# RIGOR AND INTER-DISCIPLINARY COMMUNICATION


**Editors of this Collaborative Multi-Author Article**
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## Contents of this Collaborative Multi-Author Article

## Purpose and context

Nagib Callaos

This article is the initial step in a first project in a program oriented to the following purposes:

1) To address two seemingly unrelated issues: ***Meta-Education*** (including continuous self-education) and ***Peer-reviewing.***[1]
2) To suggest a methodology based on systemic/cybernetic relationships between ***Co-researching and Co-Learning*** (Figure 1)[2]; which may increase the effectiveness of both Meta-Education and Peer-reviewing by cybernetically relating them with co-regulative negative feedback and feedforward, as well as with co-additive or co-amplificatory positive feedback.
3) To generate *internally integrated publications.* The latter would support ***knowledge integration*** processes for both: authors and readers of the respective publication.

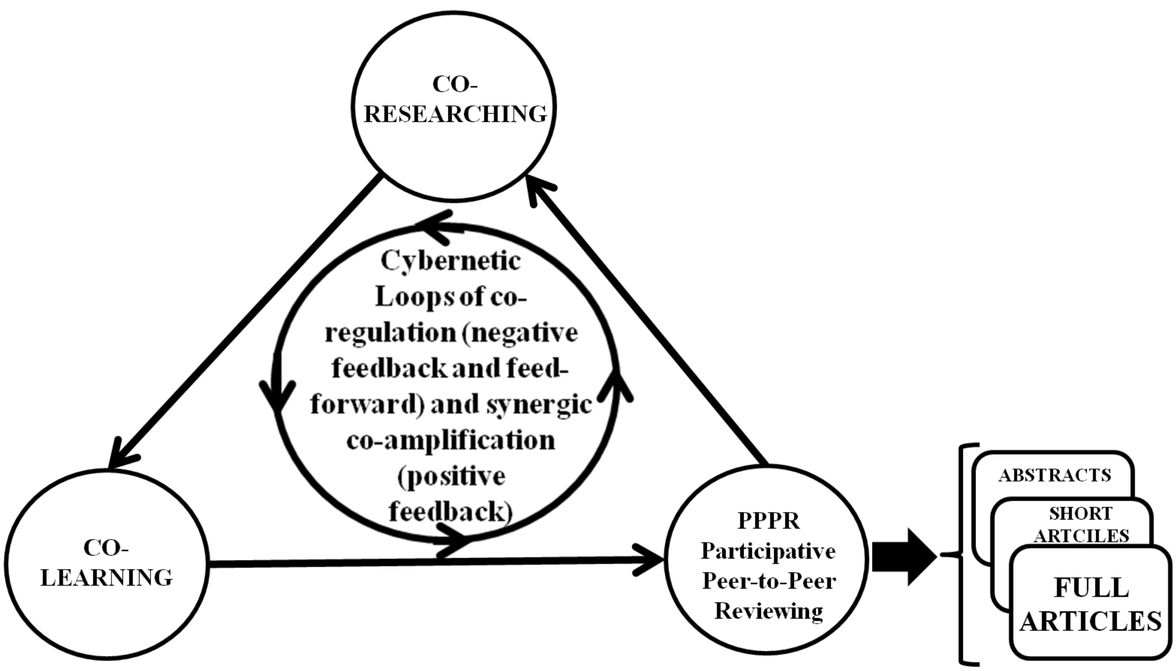


**Figure 1:** Non-linear perspective for a scholarly publishing methodology. It is being impended by means of the steps briefly described in Figure 2. The implementation meta-methodology is a combination of Methodological Action-Research, Action-Learning and Action-Design. Each one of these three methods is systemic/cybernetic one, because it is based on the *systemic/cybernetic relationships between thinking and doing.*

[1] Specifically, we are referring, in this article, to Participative Peer-to-Peer Reviewing (PPPR), in the context of "A Systemic-Cybernetic Model for Scholarly and Professional Reviewing and Publishing" (Callaos, 2012)

[2] More details are provided at (Callaos, 2020, Meta -Education and Peer-review via Co-researching and Co-Learning)

Figure 2, shows details related to figure 1, which include the sequence of differences reviewing stages and their respective publications.

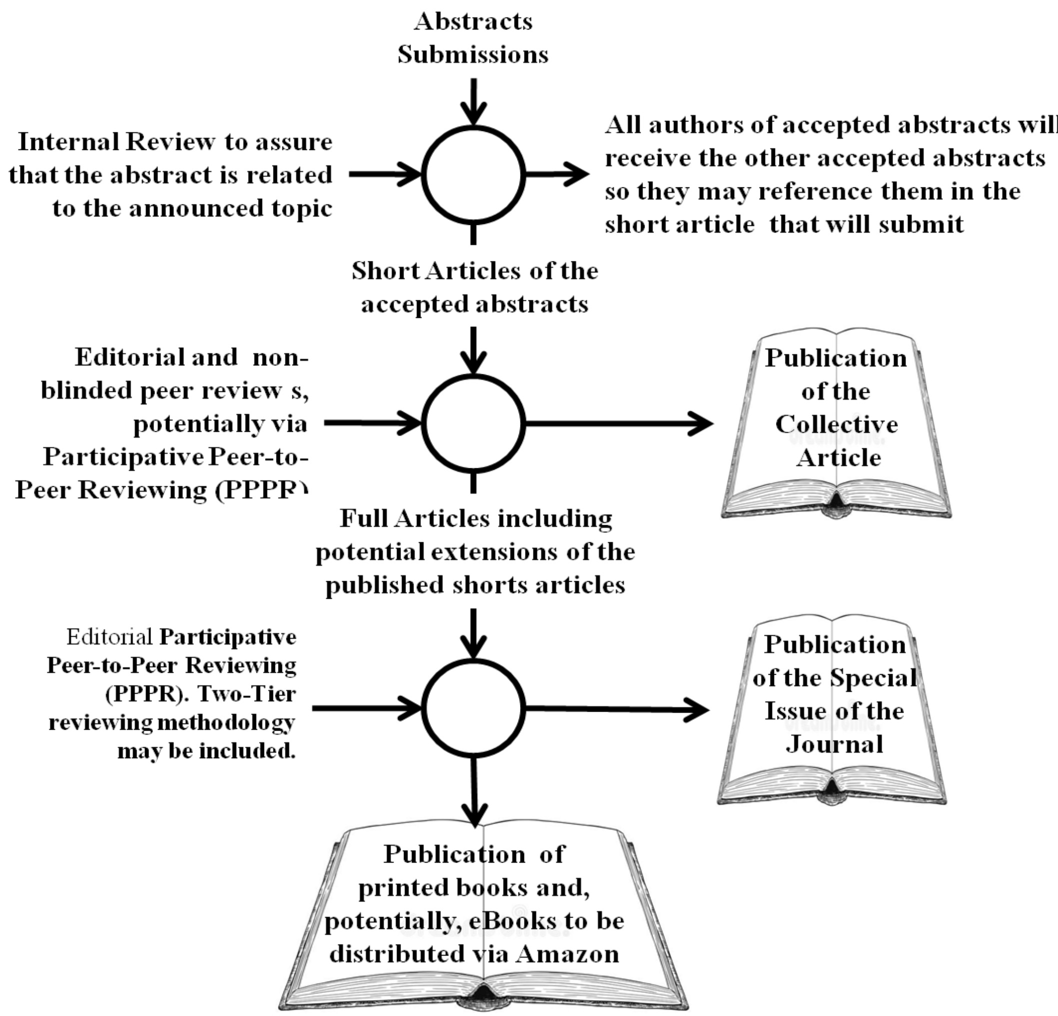


**Figure 2:** Sequence of reviewing, via co-learning, co-researching, and participative peer-to-peer (PPPR) reviewing and sequence of the respective publication.

Being the topic of this article a trans-disciplinary one, it collects contributions from different disciplinary, inter-, or trans-disciplinary perspectives. Consequently, it may, hopefully, provide support for knowledge integration on the important topic of "*Rigor and Inter-Disciplinary Communication".*

The diagram of Figure 3, schematizes the steps that are suggested for the implementation of what is presented in Figure 1 and detailed, a little bit, in (Callaos, 2020), in the context of the program oriented to *"Meta -Education and Peer-review* *via Co-researching and Co-Learning*. Figure 2 provides, as well, ***the context*** for this collaborative article. It shows, with a gray box, the positioning of this article in the context of this first project in the program, described briefly above and with more details in (Callaos, 2020).

According to Figure 3, the next step will be to use this collaborative article in a Call for Participation oriented to the next systemic/cybernetic cycle, which is a collaborative and integrated *Special Issue* of the Journal of Systemic, Cybernetics, and Informatics. The production of this special issue will also be supported by co-learning and co-researching processes, in the context of Meta-Education and Partcicipative Peer-to-Peer Reviswing (PPPR), i.e. we will use the same systemic/cybernetic methodology used for this collaborative article but, based on it and oriented to the publication of a Special Issue of the Journal.

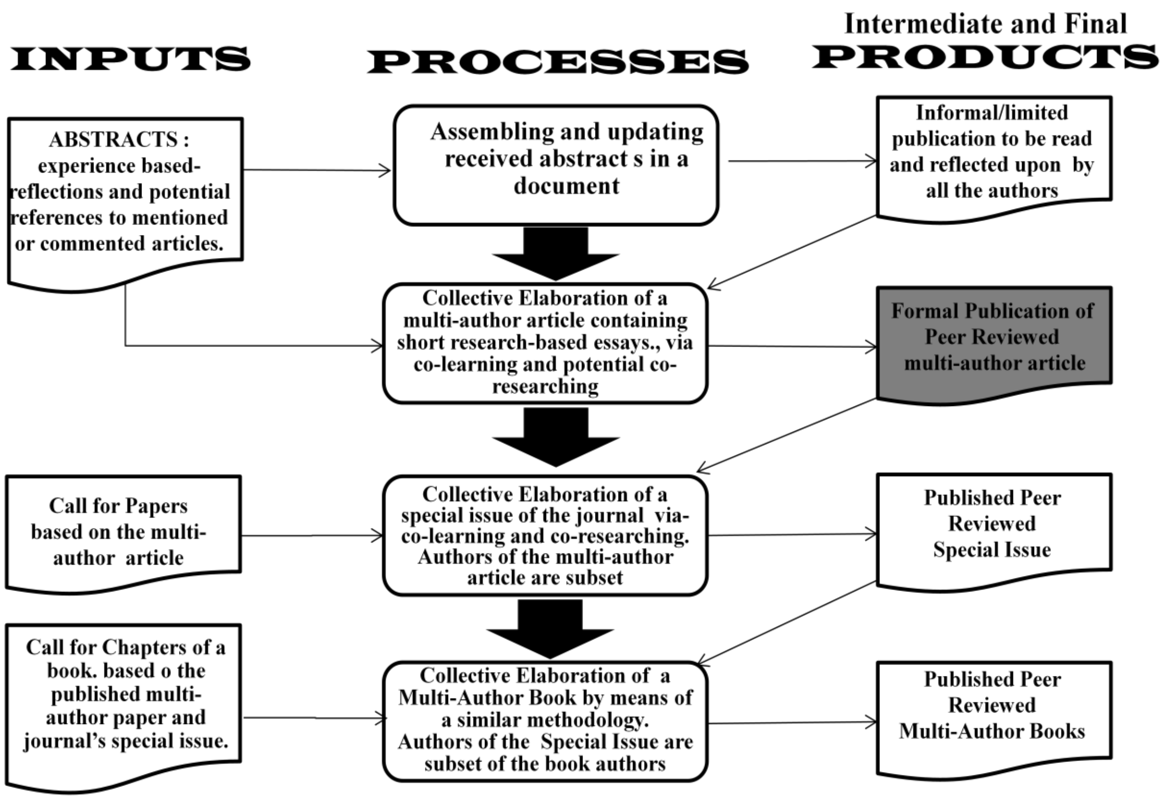


**Figure 2**: Steps in which it is being implemented the systemic/cybernetic model proposed in figure 1; which has been described and reasoned in (Callaos, A Systemic-Cybernetic Model for Scholarly and Professional Reviewing and Publishing, 2012)

## References

Callaos, N. (2012). *A Systemic-Cybernetic Model for Scholarly and Professional Reviewing and Publishing.* International Institute of Informatics and Systemics (IIIS). Orlando: International Institute of Informatics and Systemics (IIIS).

Callaos, N. (2020). *Meta -Education and Peer-review via Co-researching and Co-Learning.* Orlando: International Institute of Informatics and Cybernetics: IIID.

# Interdisciplinary Communication Rigor[1]

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***Abstract***

*The purpose of this article is to trigger an Inter-Disciplinary Dialogic on the Topic of "Inter-Disciplinary Communication Rigor" which may be also called "Inter-*Disciplinary Dialogic *Rigor".*

*This article is the result of a collaborative work supported by co-researching, co-learning, and co-reviewing; oriented to generate an internally integrated collection of articles from a different disciplinary perspective, on a trans-disciplinary topic, in order to support authors and readers in knowledge integration processes.*

*A light Participative Peer-to-Peer Reviewing (PPPR) pass supported the reviewing of this article as well as the following ones. Some authors informed about the learning process they went through reading and, potentially, reviewing this article and the others that were triggered by it. This learning process was mostly based on other disciplinary or inter-disciplinary perspectives. This stimulated their analogical thinking, as it was expected by the authors of this article. It is good to reiterate what is well known regarding analogies as creative sources and analogical thinking as providing input to logical thinking, e.g., hypothesis to induction, conjecture for deduction, plausibility for abduction, etc.*

*Keynotes: Rigor, Inter-Disciplinary Rigor, Dialogics, Symposium, co-researching, co-learning,*

## 1. Introduction

The phrase "Inter-Disciplinary Dialogics", mentioned in the abstract, was inspired by Jeremy Horne's article, appearing immediately after this, entitled *"Unedited notes on*

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[1] We are using the word "Rigor" in the context of "Intellectual Rigor": logical and/or methodological rigor, i.e., subject and complying with logical and/or methodological rules, restrictions and standards. More details with regards the notion of "Intellectual Rigor" are briefly given below

*interdisciplinary communications – historical perspective, rigor and current situation*". In this short article, Jeremy Horne relates a very brief historical account of issues related to "Inter-Disciplinary communication". In this context, he mentions "Aristotle's Dialogic". Here we are using the term "Dialogics" in its general meaning (increasing consensus via collective construction of 'logos'), which includes "Aristotle's Dialogic". In its general sense, Dialogic is the kind of communication implemented via Dialogue. Interdisciplinary Communication, as a dialogue, i.e., is a dialogical inter-disciplinary communication as presented with more details in *(Callaos & Horne, 2013).*

The articles following, and the final version of this article, were in part inspired by workshops, presentations, and discussions at the 2019 IIIS meetings in March and July, and in many ways, this collection should be viewed as a written symposium, where Dr. Horne's article and an early version of this article served as the foundation for interaction. As such, many of the keynote presentations (and their recordings) from those conferences, and the consequent invited articles in the Journal of Systemics, Cybernetics and Informatics [JSCI], can be thought of as complementing this "symposium". See, for example, (Marlowe & Herbert, 2019) and (Herbert & Marlowe, 2019).

Wilhelm von Humboldt (1836) was one of the precursors who perceived the necessity of inter-disciplinary communication or, more precisely, inter-disciplinary dialogues.[2] He affirmed:

> "With a clear and immediate sense of his immutable limitations, man is bound to regard truth as something lying outside him: and one of the powerful means of approaching it, of measuring his distance from it, is social communication with others. All speaking, from the simplest kind onwards is an attachment of what is individually felt to the common nature of mankind." (Humboldt, 1836, p. 57)

[2] Interestingly, von Humboldt's younger brother, the naturalist and scientific polymath Alexander von Humboldt, was very much of the same mind: "In September 1828, [Humboldt] invited hundreds of scientists from across Germany and Europe to attend a conference in Berlin. Unlike previous such meetings, at which scientists had endlessly presented papers about their own work, Humboldt put together a very different programme. Rather than being talked *at*, he wanted the scientists to talk *with* each other. ... He connected the visiting scientists on a more personal level, ensuring that they forged friendships that would foster close networks. He envisaged an interdisciplinary brotherhood of scientists who would exchange and share knowledge. 'Without a diversity of opinion, the discovery of truth is impossible,' he reminded them in his opening speech. (Wulf, 2015, p. 231).

This important relationship with Humboldt´s intellectual perspective was prompted by the following comment informally made by Professor **Detlev Doherr** to the first draft of this article, providing the following reflection:

> "I wonder how we could compare the situation of the intellectuals from the past to our today's situation. As it is known, Humboldt did not have to change to think interdisciplinary, because most scientific disciplines weren't existent at that time. Another topic is dealing with the interaction and interconnection of natural processes. How, if not by interdisciplinary communication, can we detect natural processes and find our view of nature? Let me point out, that we have several views of nature depending on scientific disciplines, the social environment, and the time. Please compare the advantages of astronomy research and detection of black holes! Nobody before Stephen Hawking had the power of imagination and intellectual property to detect such a phenomenon. Or the question of human intelligence, which we try to describe by machine logic and algorithms! I am glad and I am sure, that the nature is not so easy to understand as some of us believe! And we have only one way to find out more about our nature, which is the communication and power of imagination."

Via analogical thinking, we might paraphrase Humboldt, suggesting that disciplines (or disciplinarians), with "a clear and immediate sense of [their] immutable limitations" [are] bound to regard truth as something lying outside [them]: and one of the powerful means of approaching it, of measuring his distance from it", in inter-disciplinary communication or dialogs.

## 2. Intellectual Rigor in Inter-Disciplinary Communication

Elsewhere, we have examined the meaning and the importance of interdisciplinary communication (Callaos & Horne, 2013) (Callaos N., 2017). Here we will, very briefly, refer to what is, or should be, rigorousness in the context of interdisciplinary communication. One frequently reads (or hears) that interdisciplinary research, education, and/or communication is not rigorous. This is far from the truth, if the communication is based on rigorous and critical thinking, and especially if it is

based on a previous intra-disciplinary peer review, or the interaction of several works that have sustained such review, potentially in different disciplines.
We will show that, contrary to what some disciplinarians believe, rigorous inter-disciplinary communication could even be more rigorous than intra-disciplinary communication. This is especially correct in situation C described below, which will be the means with which we will start the project of *interdisciplinary written communication* conceived as a complement to the verbal inter-disciplinary communication that the International Institute of Informatics and Systemics (IIIS) has been implementing through its conferences during 23 years.

We will describe the notion of "Intellectual[3] Rigor" in a coming article; meanwhile, we will use the term "rigor" in its senses of "*strictness*" and "*validity*."[4]

Intellectual Strictness requires thinking and acting[5] in close conformity to requirement, rules, logic, principles, and constraints; that is, thinking and/or acting in the context of *restrictions*. Because of ethical restrictions, as well as the need for integrity in the research process, *intellectual honesty* is a necessary condition for intellectual rigor, though not a sufficient one.

In this article, "intellectual rigor" means logical, epistemological, and/or methodological strictness, i.e., playing by the rules and within the boundaries of the respective logic(s), epistemology(ies), and/or "methodology(ies)". Our intellectual stance in this article is Epistemological Pluralism, Methodological Pluralism, and/or Logical Pluralism. This pluralism is required because the subject matter is on the Rigor of Inter-Disciplinary Communication which necessarily requires Inter-Disciplinary Thinking (internal communication that may require creativity), upon an equally rigorous foundation within its component disciplines.

Intellectual Validity requires "the quality or state of being valid" [i.e] "well-grounded or justifiable: being at once relevant and meaningful … logically correct a valid

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[3] In this article we are using the word "intellect" in its general meaning, i.e., as the faculty of thinking, reasoning, knowing, and understanding, in any of their conceptions or species, including, practical and/or theoretical thinking, explicit and/implicit knowing, qualitative and/or quantitative reasoning, logical and analogical thinking, etc.

[4] We should be aware that, as Guba and Lincoln affirmed in (Paradigmatic Controversies, Contradictions, and emerging confluences, 2005), a "radical reconfiguration of validity leave[s] researchers with multiple, sometimes conflicting, mandates for what constitutes rigorous research." (p. 205)

[5] Communicating is one form of acting.

argument valid inference … *appropriate to the end in view: effective.*” (Merriam-Webster, 1999) [Italics added]. This teleological connotation of the notion of validity is repeated in, at least, another dictionary. At (Dictionary.com), we find the definition of validity as thinking and/or acting oriented to “produce a *desired result; effective*” [Italics added]. Other definitions in other dictionaries can be conceived as one kind of results. For example “being logically or factually sound; soundness or cogency,” (Oxford Dictionaries); “being correct or true” (Your-Dictionary); “being based on truth or reason, or of being able to be accepted” (Cambridge Dictionary). Consequently, validity is mainly characterized by restrictions and objectives, i.e., 1) restriction to rules, standards, logics, methods, semiotic system, etc., and 2) orientation to ends, objectives, telos. The latter would be measured by the degree of effectiveness of the associated thinking and/or action. An interesting comparison is to the meanings in software development: *verification* is used to prove that one has solved the problem correctly; *validation,* that one has solved the correct problem—corresponding to the specified requirements, constraints, and as far as possible, objectives. Consequently, *the more restrictions are honored and the more objectives are met, the more rigorous is Intellectual Thinking and/or Communicating.* The more effective is thinking and communicating, the more rigorous it is. *In our case, the more people from other disciplines can understand an article, the more rigorous is in the context of inter-disciplinary thinking and communication.*

This short article has the purpose of providing context and communicating the reasoning required *collecting more information, knowledge, and opinion* (Episteme and Doxa) with regards to the Rigor of Interdisciplinary Communication, in general, and/or with regards to the three situations we briefly describe below. First, we provide a brief overview of the literature on “inter-disciplinary rigor”. This would support and enhance the context, we would like to provide, as briefly as possible.

## 3. Different intellectual Perspectives Regarding “Rigor and Inter-Disciplinary Communication

To the best of our knowledge, the most comprehensive book on Inter-disciplinarity was authored by Julie Thompson Klein (Thompson Klein, Interdisciplinarity: history, theory, and practice, 1990) (Thompson Klein, Interdisciplinarity: history, theory, and practice, 1990) (Thompson Klein, Interdisciplinarity: history, theory, and practice, 1990). About 40% of the book consists of her references. With regard to interdisciplinary rigor, she wrote:

> Interdisciplinary work is often attacked for lacking rigor. However, rigor is not diminished. Rather, it is shifted from disciplinary criteria to a new interdisciplinary *objective,* to what (Singleton, 1983) call a core sense of "interdisciplinary rigor." There are no scholarly defined standards for judging interdisciplinary works but Stephen Schneider's three criteria for disciplinary excellence are quite appropriate. Excellence of interdisciplinary research can be measured in terms of (1) disciplinary clarity, (2) clarity of cross-disciplinary communications, and (3) the utilization and combination of existing knowledge from many fields to help solve a problem or to raise or advance knowledge about a new issue (Schneider, 1977).

Bernikova and Redkin, in an article (included in this multi-author paper) entitled *"Intellectual Rigor in Arabic Studies and Computer Sciences Communication"* seem to have the perspective similar to that of Thompson Klein, i.e., that inter-disciplinary rigor requires a different kind of rigor, a one than "minimization of requirements of each of the disciplines in the context if inter-disciplinary dialogue". This may mean that we should pay the cost of decreasing the intra-disciplinary rules in order to increase the communication among disciplines. There is a tradeoff that should be made between intra-disciplinary and inter-disciplinary rigor. The latter requires communication among disciplines in order to deal with problems that require effective communication among the disciplines involved in the solution of a real-life problem. In our opinion, as we will see below, this tradeoff requires more, not less, rigor because requires meeting the objective of solving a real-life problem while increasing the intellectual restrictions, i.e., those required to have effective inter-disciplinary communication. We will provide, below, more reasons and details with regards to this perspective.

Ekaterini Nikolarea, in another article entitled *"'Intellectual rigor' and beyond: Inter-disciplinary communication in a glocalized context (or inter-scientificity)",* also included in this multi-author paper, challenges the concept of intellectual rigor (in the context of a discipline) in inter-disciplinary communication and discusses "how it should be expanded" in order to include scientific thinking and communication "between at least two different linguistic [or semiotic systems, as we will see below, should] develop (1) **uncertainty and stress tolerance for unknown scientific terms** when trying to communicate their ideas in a different linguistic scientific environment; and (2) **association skills**, that is, skills in finding equivalences in two different linguistically discourses," These association skills are in our opinion most often analogical thinking skills (which provide input to logical thinking), together with skills for using metaphors and similes to express themselves to an audience from other disciplines. As we will see below, what Ekaterini Nikolarea is suggesting would increase the level of rigorousness of the communication as long as the content has been previously reviewed by peers from the same discipline, that is, those proficient in the disciplinary semiotic system and its associated research methodology. To ***add*** *"uncertainty and stress tolerance for unknown scientific terms and association skills"* is to add intellectual restrictions, skills and objective to the initial disciplinary research. This makes inter-disciplinary communicating more, and not less, rigorous, as long as this communication is effective. We will provide, below, more details and adequate reasoning with regards to this issue.

From a more general perspective, Jeremy Horne[6], referring to an achievable rigor (not an ideal one warranting the Truth), suggests,"Let's settle for what philosophers uphold as criteria for objectivity – coherence, correspondence, and consensus. Scientists look to independent discovery of the same phenomena." The latter provides the standard of consensus in the experimental sciences. But, more generally, are we talking here about John Locke's Consensual Truth, as C. West Churchman called it? (Churchman, 1971) If so, then let us add Singer-Churchman's Pragmatic Teleological Truth, which is based on means-end logic (next paragraph). As long as we comply with further rational rules and restrictions, we will have a higher level of rigor, by definition of intellectual rigor. Hence, if we add to experimental methodological rules and to inductive logic restriction, the means-end logic, then we certainly would be increasing the rigor level of our thinking and, hence, the rigor of our communication. If, on the other hand, the initial artifact belongs in whole or in part, not to the experimental sciences, but (say) to the formal sciences, then the standards of those disciplines (for example, formal proof) will have to be considered instead of or in addition to experimental replication.

[6] In a short research-based reflection article (in this multi-author paper) entitled "Unedited notes on interdisciplinary communications – historical perspective, rigor and current situation", Jeremy Horne provides a very brief historical account of "Inter-Disciplinary Communication" in order to identify what rigor is or should be, in the context of inter-disciplinary communication. He provides analogies and metaphors to express why inter-disciplinary communication is a necessary condition for achieving a real rigor.

Professor Donald Ropes, in an article in this multi-author collaboration entitled "Interdisciplinary Communication as a Process and an Outcome: The Case of Trans-disciplinary Research" makes an important conceptual distinction, related to our two above paragraphs. He differentiates among "1) declarative knowledge (*épistémè)*, which is about the current state of the system, and can take the form of a new testable hypothesis or contributions to theory 2) transformative knowledge (*praxis* or *poïesis)*, which considers what the innovation should achieve and could be embodied in new products, services or policy insights and 3) transformational knowledge (*phronēsis)",* i.e., practical understanding. In the context of this very important conceptual differentiation, to *effectively* combine *épistémè and praxis*, i.e., intra-disciplinary knowledge and an effective action-oriented to solve real-life problems, it is ***necessary*** to increase the intra-disciplinary rigor by the rigor of being effective in solving real-life problems, which are almost always multi-disciplinary ones requiring and generating inter-disciplinary (verbal and/or written) communication. To the rigor required by inductive and/or deductive logics, it is necessary to add another rigor level required by means-end logic, or the Singer-Churchman pragmatic-teleological truth. To be effective applying the means-end logic necessarily requires *phronēsis* which means that a transformative knowledge should be created or a practical understanding should be achieved, especially with regards to the interaction of the created solution (policy, technology, methodology, etc.) with its social and human environment. As is apparent, this requires not just the rigor of intra-disciplinary rigorous knowledge, but ***also*** the rigor required by 1) means-end logic and 2) the necessary rigor of *phronēsis*, that is, practical understanding, or transformative knowledge. Technical and practical know-how are necessary conditions for applying any intra-disciplinary rigor to the solution of real-life problems.

In the context of the last three paragraphs, we notice the additional rigor required for being effective (no just efficient) in solving the kind of real-life problem that Margit Scholl briefly describes in her article, in this multi-author collaboration, entitled "Short reflection on the outlook for E-Government in Germany with a focus on the "Rigor of Interdisciplinary Communication**"**The real-life problem Scholl describes is a multi-disciplinary one that requires and generates inter-disciplinary communication. The effectiveness of this communication depends on adding the rigor required making an effective translation between the different disciplinary semiotic systems (which require additional creativity, though not necessarily originality) and this, in turn, requires *épistémè* and *phronēsis*. Once the inter-disciplinary communication has been effective, then, it requires the additional rigor of being subjected to the means-end logic and a combination of technical and methodological *praxis* and social/human *phronēsis* with the users and/or potential users of the solution (e.g., an information system, a policy, an innovation, a procedure, a methodology, a technological device, etc.) in order to solve that real-world problem.

Consequently, in general, if we add the restrictions of 1) complying with Singer-Churchman's pragmatic- teleological truth (Churchman, 1971), i.e., the Means-End Logic (e.g., achieve a goal, objective, or purpose) and 2) practical understanding (*phronēsis)* to the disciplinary rigor, *what we get is more, not less, intellectual rigor.* This will get clear in the below-described Situation C, of interdisciplinary situation, where after, and only after, disciplinary rigor had been judged via disciplinary peer review, then, and only then, an additional rigor (restrictions, rules) is added. This additional restriction or rigor is to comply with the Means-End Logic or the Singer-Churchman's Pragmatic-Teleological Truth of the Systems Approach (Churchman, 1971), as well as with *phronēsis (practical understanding in the case of real-life problem solving).* This will provide additional, often illuminating, complementary reviews from researchers, scholars or professionals from other disciplines, as well as from users of the implemented solution if a real-life problem is faced.

## 4. Inter-Disciplinary Communication Rigor

It is our understanding that interdisciplinary communication is produced, in at least the following situations:

A. ***Interdisciplinary research*** via ***multi-*** or ***cross-disciplinary*** teams, where multi-disciplinarity is understood as an informal juxtaposition of insights from two or more disciplines, and cross-disciplinarity includes some level of knowledge integration among two or more disciplines. This requires a minimum of ***common*** knowledge in order to ***commun***icate the members of the team. We would like to suggest that multidisciplinary teams are related via insights and opinions (Doxa) while cross-disciplinary teams are also related via knowledge (Episteme)

B. ***Trans-disciplinary topics*** or conceptual structures.

C. ***Translating***[7] (partial or total re-writing) of peer-reviewed ***intra-disciplinary*** research and communication with the objective of interdisciplinary communication.

A case combining modes A and C can occur when the underlying research is already effectively interdisciplinary, but the exposition is placed entirely within a disciplinary framework. In essence, it, then, involves reversing the process of placing it in a disciplinary context, preserving the results and insights that arose while doing so, yet paying full and due attention to the interaction with other fields that may have been neglected, or confined to shadows within the language and concerns of the article's field.

**Situation A** requires disciplinary rigor **AND** the rigor of strictly solving the problem for which the team was formed. This problem may by be a technological, methodological, or organizational innovation, a health issue, an effective medical diagnosis and remediation, a solution of a socio-political problem, etc. The best real-life test in meeting the additional rigor, beside the intra-disciplinary rigor, is the solution of the problem, which can be observed by any peer and even non-peers. Consequently, effective multi- or cross-disciplinary teams are more rigorous. The rigorousness of their interdisciplinary communication can be observed, verified and validated by peers and, eventually, by non-peers.

***Situation B*** requires *general disciplines* as, for example, Cybernetics, System Approach, Philosophy, Mathematics, Logic, Design, critical thinking, etc., and *meta-disciplinary approaches* as, for example, meta-science, meta-engineering, meta-research, meta-design, meta- education, meta-philosophy, meta-logic, meta-history, etc. Consequently, the intellectual rigor in situation B is the rigor associated with the respective discipline or meta-discipline.

***Situation C*** requires both the disciplinary rigor verified by known and much used peer-reviewing processes **AND** another layer of rigorousness; which is to be restricted to what is ***common*** to different disciplines; which is, usually, adequate use of the natural language and qualitative thinking. Both things *do not lower the rigor but increase it. Disciplinary rigor should not be confused with disciplinary precision.*

[7] We are using the term "translation" in it general sense or meaning, which will be briefly described below, i.e., in its meaning of translating between two Semiotic Systems, not necessarily between two natural languages which are a special case of two semiotic systems. Meanwhile, let us understand the term as an expressive metaphor referring to translation between two natural, or non-disciplinary, languages.

Using natural language may lower the level of disciplinary precision, but not be an excuse to lower the disciplinary rigor. The author of an article based on an intra-disciplinary communication should interpret and translate it into a more common language, which *might be less precise but not less rigorous*. More precision may include referring 1) to an article written for intra-disciplinary communication for those readers who are interested in more precision and/or 2) to appendixes attached to the same article and/or 3) to footnotes. Frequently, to interpret and translate intra- to inter-disciplinary knowledge requires comprehension, and not just understanding, of intra-disciplinary knowledge. Who is better than the intra-disciplinary article's author to interpret and translate such a paper with the objective of making it accessible to other disciplinarians? Notice, please, that this adds another layer of rigorousness which is to be ALSO restricted to the means-end logic without violating the respective disciplinary logic(s). This requires an additional mental effort and additional creativity potential. This brings to mind a Charles Mingus' famous phrase *"Making the simple complicated is commonplace; making the complicated simple, awesomely simple, that's creativity."* Intra-disciplinary precision is frequently achieved with the cost of increasing complexity in what is being described in an intra-disciplinary communication. This is, in our opinion, a ***necessary condition*** for disciplinary scientific and technological advancement, but it is not *a* ***sufficient condition*** for relating disciplines, i.e. for any kind of knowledge integration required 1) for the partial integration needed for a specific real-life problem solving or 2) for a more general integration required by the advancement of human beings as human beings.

To conclude this discussion, let us return to the words of Julie Thompson Klein. Referencing (Schneider, 1977), she affirms that, "excellence is not to be measured in terms of disciplinary originality but, instead three criteria [mentioned above] that acknowledge the importance of disciplinary accuracy while allowing the *creation of new meaning*: disciplinary clarity, the clarity of cross-disciplinary communications and the combination of the existing knowledge to help solve a problem or to raise or advance knowledge a new issue … Ultimately, then, the [inter-disciplinary communication] depend[s] on the quality of both disciplinary and interdisciplinary communication, on a fuller reciprocity of "text" and translator" (Thompson Klein, 1990, p. 94). [Italics added]

In two articles resulting from keynote presentations by the second author at the IIIS July 2019 conference, written with Katherine Herbert (Marlowe & Herbert, 2019) and

(Herbert & Marlowe, 2019), the authors consider the need for a multidisciplinary, interdisciplinary, and even cross-disciplinary perspective in education, research, and practice in STEM (Science, Technology, Engineering, and Medicine) fields, including data science. STEM professionals, it is argued, need to be able to work in interdisciplinary teams, on interdisciplinary problems, and to communicate with colleagues from other disciplines, both within and outside STEM, with managers and other business specialists, with foundations and government agencies, and with the general public. In each case, both the precision and rigor of the analysis may need to be preserved, but translated into a new domain. The articles also suggest that, with the increasing importance of data science, social media, automation, and the Internet of Things, as well as the rapid—if not always beneficial—progress of modern science, technology, and engineering, non-STEM specialists can benefit from integrating, and in many cases arguably must integrate, an understanding of STEM into their intellectual worldview, including an understanding of technical communication.

Yet even that does not encompass the full scope of possibilities for and constraints upon inter-disciplinary communication. In some cases, particularly in Situation B disciplines (to which we would add within the formal sciences much of Computer Science and some aspects of Data Science), there is the possibility of significant knowledge that is inherently intra-disciplinary, even if it has interdisciplinary ramifications. The results of Gödel, Turing, and other impossibility theorems clearly don't solve problems—in fact, they instead constrain the set of problems that can be solved, at least within specific if very general formal systems. The Heisenberg Uncertainty Principle is an example of a similar formal result in the natural sciences, as is Arrow's Impossibility Theorem in the social sciences. And they are necessarily posed and demonstrated within the discipline or the formal sciences.

In these cases, interestingly, our argument is in some sense reversed. While interdisciplinary formulation cannot add to the *rigor* of the result, it is very important in communicating the *precision*: where and how the results apply and where they do not. Too many popular and even academic works have badly misinterpreted or even abused quantum physics, mathematical incompleteness or undecidability, and like results, showing the necessity of this work.

This is what we are trying to achieve with the above-mentioned situations, especially, but not uniquely, in situation C in order to work out the initial steps with which we are planning to continue fostering interdisciplinary communication. For 23 years, we have been trying to foster this kind of communication via conferences in which we tried to integrate traditional intra-disciplinary with inter-disciplinary presentations.[8] The latter have mainly been done via ***verbal*** communications at plenary and conversational sessions, as well as via interdisciplinary workshops and participative panels, on the first day of the conferences. In this new phase, we are trying to foster ***written*** interdisciplinary communication.

## 5. Translation between Two Different Semiotic Systems:

We frequently used, above, the word "translation". We are providing, in this section, a very short description of the specific meaning in which we are using this term. A more detailed description would require a complete paper of its own, which is planned for the near future.

Disciplinary communication is based on what we might call Disciplinary Semiotic Systems with their own Syntactics, Semantics, and Pragmatics. Bernikova and Redkin, mentioned above, in an article (included in this multi-author paper) entitled *"Intellectual Rigor in Arabic Studies and Computer Sciences Communication,"* refer to their research experience related to "translating" 1) between the semiotic system of a *natural language* (the Arabic) and the *artificial languages* of Computer Science and 2) among the different disciplines required for solving the kind of problem they face in their research. We suggest that their experience is similar to those who develop information systems to support activities generated by professionals from different disciplines. Information Systems analysts have similar kinds of problems that require translation between natural disciplinary languages, artificial languages, and formal (e.g., mathematical) formulations, i.e., among different natural and artificial semiotic systems. In Bernikova and Redkin's case they should also achieve an adequate translation among different natural languages, i.e., Arabic, Russian, English, etc., as well between these and artificial languages.

[8] More details regarding this issue have been posted at (Callaos N. , Higher Education or Higher Instruction?, 2015)

Ekaterini Nikolarea, in an article included in this multi-author collaboration, provides a great metaphor, which is even, in our opinion, a potentially very effective tool for analogical thinking. She uses the term "Glocalization"[9] to refer to what is needed for inter-disciplinary communication. She shows "how the concept of 'inter-disciplinarity' of a scientific field/domain in *glocalized* environment – … (1) draws upon different disciplines and recontextualizes its vocabulary to meet its specific needs and (2) carries polysemy of scientific discourse." This is required for translation among disciplinary semiotic systems, which make inter-disciplinary communication more, not less, intellectually rigorous, as long as 1) the essence of the communicated contents does not go against what is accepted in the disciplinary semiotic systems involved and 2) the inter-disciplinary communication is effective. Adding inter-disciplinary effectiveness to complying with the disciplinary semiotic and methodological systems, increases the number of restrictions and objectives to the intellectual process, hence, by definition (and according to our above reasoning), it increases its rigorousness. An adequate translation between semiotic systems is required for the effectiveness of any inter-disciplinary communication

A much known good example is the required Semiotic Translation in Mathematics Education. Presmeg et. al. (Semiotics in Mathematics Education, 2016), for example, affirms that one of these dimensions "*is the relationship among sign systems (e.g., natural language, diagrams, pictorial and alphanumeric systems) and the **translation** between sign systems in mathematics thinking and learning*." (Presmeg, Radford, Roth, & Kadunz, 2016, pág. 26) [Italics and emphasis added]. The other dimensions of Mathematics Education apply as well, but for the sake of simplicity and the brevity required in this article, let us just mention this dimension as an example of *"translation"* between semiotic systems, which is the sense in which we used the word above. This example in mathematics applies to any discipline or disciplinary

[9] The neologism "glocal" is an adjective related to characterizing "local and global" simultaneously. "Glocalization" is also a neologism that refers to the simultaneous coexistence of "globalization" and "localization". Two seemingly opposite notions had been associated to "glocalization": 1) "In the marketing context [for example], glocalization means the creation of products or services for the global market by adapting them to local cultures" (Blatter, 2013); 2) in "education has been proposed in the specific areas of politics, economics, culture, teaching, information, organization, morality, spirituality, religion and 'temporal' literacy. The recommended approach is for local educators to consult global resources for materials and techniques and then adapt them for local use. For example, in information, it involves advancing computer and media understanding to allow students and educators to look beyond their local context." In many cases, these two opposites are polar ones, i.e., they may complement each other, have cybernetic relationships and, hence, generate synergies. This is, in our opinion, the case of inter-disciplinary communication and it is our interpretation of what Ekaterini Nikolarea is proposing.

research to be delivered, orally or via written material, for inter-disciplinary communication with a multi-disciplinary audience or readerships.

We think it is necessary to provide some context to the rigor of Mathematics Education and other exact sciences, as related to their educational processes, especially because the context is not as simple as the above paragraph may indicate.

## 5. Mathematics Education vs. Mathematics as a Discipline.

To provide context, especially in what relates and differentiates *Mathematics Education and Mathematics as a Discipline,* let us look at two different areas, which become three in computer science and, potentially, in other sciences.

The first is between teaching formal mathematics versus the practice of pure mathematics. Pure mathematics as a practice uses rigor as a toolkit and a validating instrument in the exploration of new intellectual territory—by expanding what is known about systems or by modifying definitions and assumptions to understand new systems (which may be specializations, generalizations, mutations, or tweaks of current systems). The results may be very small, or large and consequential—and it is often hard to know how significant the results will be before the exploration has begun. Mathematical education, on the other hand, largely inherits its intellectual rigor, and typically provides limited challenges with fixed targets to the student, who admittedly has to demonstrate the same rigor in carrying out those exercises. Even in undergraduate research in mathematics, the results may not be known, but the roadmap is usually well understood--although, there are occasional wonderful exceptions, either in the student or in the results.

The second is between the teaching of applied mathematics and the practice of the same. The teaching of applied mathematics most often presents a set of techniques and then asks students to solve problems using those techniques. At best, the student may have to choose among methods, and/or determine the applicability of a given method. The difficulties typically are a combination of seeing tricks and carrying out computations. The practice of applied mathematics, on the other hand, looks first for appropriate models, and validates their applicability (at least “mostly”) upfront. It then looks for the appropriate relationship (differential equation, matrix formulation, statistical tests, etc.) and tries to solve the problem in one or more ways. Finally, it validates the final solution, and where possible, looks for fragility in the initial information (what changes would have required a modified approach, or resulted in a very different solution?) and possible follow-up explorations. [On the other hand, one has to admit that there are programs—at the United States Military Academy (West Point) for one—that give freshmen and sophomores largely unconstrained engineering/applied mathematics problems and ask them to explore formulations, approaches, and (partial) solutions using the full scope of their knowledge and their courses.]

Finally, in computer science, in addition to the logical theory of programming and of computability, and the application of computer techniques to software development and other problems, there is the system dimension—physical hardware, architecture and organization, networking, and program translation. Practice entails considering and developing physical, structural, and low-level programming alternatives for components such as processors, memory, processes and threads, communication, and more. On the other hand, although, while teaching this material, one may ask students to consider tradeoffs among existing alternatives, or to build or emulate parts of the system, students are rarely if ever developing new components or combining them in novel ways, except perhaps under faculty direction.

In sum, although the mathematics being taught is constrained by the same requirements and rules as the mathematics being developed by researchers, the processes are by no means equivalent, and the rigor in the development of mathematics is far more of a barrier in research than it is in education.

This can be compared to research in the non-theoretical areas of science, where upper-level undergraduates may be using most of the same techniques and procedures as the researchers, and may even participate (largely in a role as technicians) in carrying on that research.

It may also be conceived that the development of mathematics has a different kind of barrier in research than in education. Let us offer very brief reasoning regarding this issue.

Tons of books and articles[10] have been written on the methods of analysis and synthesis since the Greeks started thinking and writing about methods in Geometry. Briefly, *analysis is a method of discovery and synthesis is the proof*, in other words: *analysis is the method of discovery of the truth and synthesis is the method of its presentation.* Consequently, the methods followed by mathematicians in pure mathematics are largely (but not only) those of analysis while the mathematics education needs to present the discovered truths to the students, and so uses primarily synthetical methods. Having clarified this difference, we now need also to clarify that analysis and synthesis may be conceived as two sides of the same coin. Since they require, define, and complement each other, they could be conceived as polar opposites. They also could be conceived as related in cybernetic loops including co-regulative (negative feedback and feed-forward) and co-amplificatory (positive feedback (loops)).

Analysis and synthesis require each other in such a way that authors, like Lakatos, present them as *one method*, in the context of a *heuristic thinking* (as contrasted with algorithmic one). Lakatos points out that this 'combined' heuristic method of 'analysis-synthesis' was the essence of what was recommended by ancient Greek philosophy, especially in the area of Geometry. He resumes this hybrid and heuristic method (in what he named as an associated '***rule of analysis and synthesis'***) in the following text (that might be perceived as one of the clearest ways in which the analysis-synthesis method has been stated, in few words).

> "*Draw conclusions from your conjecture, one after the other, assuming that it is true. If you reach a false conclusion, then your conjecture is false [reductio ad absurdum]. If you reach an indubitably true conclusion, your conjecture may have been true. In this case reverse the process, work backward, and try to deduce the original conjecture via the inverse route from the indubitable truth to the dubitable conjecture. If you succeed, you have proved your conjecture*… **The first part is called analysis, the second part is the synthesis."** (Lakatos, 1997, págs. 72-73) **[**Author's italics, emphasis added]

[10] For example, Michael Beaney (Definitions and Descriptions of Analysis, 2014) presents 56 definitions and descriptions related to the methods of analysis and synthesis in the context of different philosophies and epistemologies and given by the most known and reputable philosophers of Science and epistemologists.

The ***decomposition*** process of complex lemmas/theorems (whose truth is not intuitively evident) into simpler components (which represent indubitable truths: axioms, first principles, lemmas that had already been proven, etc.) should be followed by a ***compositional*** process through which we can construct the complex theorem to be proved from simple (or simpler) indubitable truths. So, unless we are can have a falsehood proof, via '*reductio ad absurdum'*, *synthesis must necessarily follow analysis in geometrical and mathematical proving processes*. Analysis is a method for *discovering* truths, and synthesis is the proof, the demonstration of the truth of a complex idea using its derivation (composition) from simpler (usually self-evident) truths. Analysis and synthesis are each necessary for discovering and demonstrating truths) and both, together, are sufficient for any proof.

In Science, in general, Tom Ritchey (Analysis and Synthesis On Scientific Method - Based on a Study by Bernhard Riemann, 1991) affirms that "Analysis and synthesis, as scientific methods, always go hand in hand; they complement one another. Every synthesis is built upon the results of a preceding analysis, and every analysis requires a subsequent synthesis in order to verify and correct its results. In this context, *to regard one method more inherently better than the other is meaningless*. (Ritchey, 1996, pág. 1)[11]

The interpretation made by Ritchey is related to the following Riemann's text, which we will copy below in order to assure to the reader the correctness of Ritchey's interpretation of such a reputable mathematician as it is the case of Riemann.

> **"Purely synthetic and purely analytic research, when taken in the precise sense of these terms, is impossibility. <u>Every synthesis rests upon the results of a preceding analysis, and every analysis requires a subsequent synthesis</u>**

[11] Tom Ritchey bases his study on Riemann and, as it is well known, he affirms that, "Riemann is known primarily for the so-called Cauchy-Riemann equations, Riemann surfaces and Riemannian geometry, Riemann's differential equation, the Riemann integral, Riemann's zeta-function and the Riemann hypothesis. However, the basis for most of his discoveries seems to rest upon his fundamental development of the theory of complex functions. The methods he developed in this area led him to other discoveries in analysis, geometry, number theory and even hydrodynamics -- subjects which today are thought of as belonging to more or less separate areas of study … Riemann's fundamental ideas on geometry were presented in his famous Inaugural Address of 1854, "On the Hypotheses which lies at the Foundations of Geometry". This short, non-technical work is undoubtedly one of the highlights in the history of science. In it, he analyses the basic assumptions which underlie geometry and develops unified principles not only for the classification of all then existing forms of geometry, but also for the creation of any number of new types of space. He later developed the basic analytical tools, which Einstein would subsequently use, in his theory of general relativity." (1996, pág. 3)

**in order that it may be confirmed or corrected with reference to experience. With the former, synthetic procedure, the universal laws of motion are simply the result of a previous, assumed analysis."** (Riemann, 1866) [Quoted by (Ritchey, 1996, pág. 16)] [Author's emphasis, underlining is ours)]

Consequently, in the case of mathematics, we suggest the following relationships (Figure 1) between the practice of pure mathematics and teaching mathematics. We also suggest that analogous relationships are (implicitly or explicitly) present in between the practice in other disciplines and its respective teaching.

Sukjin Kang identified, in a short article included in this multi-author contribution, similar relationships in *Aesthetic Communication Rigor.* As it can be noticed this short article increases the importance of synthesis relating initial synthesis to new ones with cybernetic loops that might be co-regulative feedback or feed-forward and/or synergic co-amplificatory positive feedback. The latter is what increases the creativity level in Art Practice and Art Education.

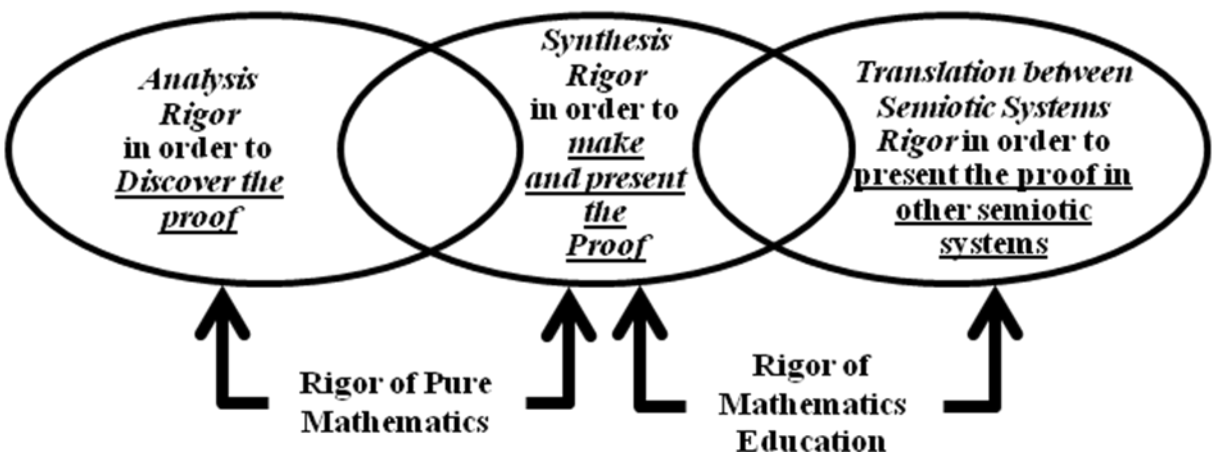


**Figure 1:** Relationships between 1) mathematical Analysis and Synthesis and 2) rigor of pure mathematics and mathematics education. Mathematical synthesis us what relate them.

Kang's short article is really an inspirational one, in spite of being short. It may certainly trigger analogies and many reflections, as well as reflexions (meta-reflections), in potential authors and readers from other disciplines. If we conceive education in any discipline as a practice that combines Art and Science, then it is easy to imagine the fertility of Professor Kang's short article for *analogical thinking*, which is an important source of the creativity required as input to *logical thinking*.

Education as an art, and not just as science, emphasizes the importance of synthesis and not just its necessity as part of the *dialectic whole*, in its yin-yang conception. Education, conceived also as an art, shows the importance of Synthesis

Even so, and even the dialectic conception of analysis and synthesis of one of the greatest mathematicians, **Georg Friedrich Bernhard Riemann**, quoted above, the notion of synthesis seems to be consigned to oblivion for so many researchers in education when geniuses in mathematics, as Riemann, are so emphatic about its fundamental role in cognition and even its necessity for the analytical method.

From another perspective, "communication" is increasingly being conceived as both Art and Science.[12] Accordingly, "Inter-Disciplinary Communication" requires an adequate blend of Art and Science. If that is so, then interdisciplinary communication requires meeting the rigor of Science as well as of Art. This adds to the above reasoning of why *effective* inter-disciplinary communication is more rigorous than that of the associated discipline(s) as long as the communication had been previously peer-reviewed in the respective discipline(s). If a written inter-disciplinary communication had not previously been reviewed by disciplinary peer reviewers, then we cannot conclude that it is more rigorous but it has a different kind of rigor, as long as it 1) is *effective* and 2) does not go against already consensually accepted scientific truth in the associated discipline(s). This adds astonishment to what we noticed above, regarding what seem to be consigning the notion of Synthesis to oblivion.

In the 1956 Bloom's taxonomy, synthesis was the second highest category recommended in the six *Educational Objectives (*Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation). In the 2001 Bloom's taxonomy was revised by a group of psychologists led by led by Lorin Anderson (a former student of Bloom). In this new version, synthesis disappeared as an educational objective or cognitive skill to be met in educational processes. This is really perplexing.

[12] For example, the second chapter of Neena Thaker's PhD Dissertation (Thacker, 2015) is dedicated to provide the reasoning of why communication is "A Blend of Art and Science". Denis Waitley (author of The Psychology of Winning), praising Pamela Perkins's book (The Art and Science of Communication: Tools for Effective Communication in the Workplace, 2005), affirmed that, "communication is both an art and a science, and to get on top and stay on top, you need to internalize both."

But, what is really astonishing and alarming is that synthesis would not even appear in the Delphi Report oriented to identify the "*Purposes of Educational Assessment and Instruction*", but 'analysis' certainly did appear identified among the six principal cognitive skills (Self-Regulation, Explanation, Inference/Querying, Evaluation, Analysis, Interpretation).

This is unbelievable, especially because the report is oriented to *Critical Thinking. This report was* produced by 47 researchers and experts (most of whom are philosophers) after several rounds of the Delphi Method during 20 months of a consensus forming process aimed at constructing a consensus report regarding the cognitive processes that should be addressed in Critical Thinking. The result of this Delphi consensus procedure has been reported in the much known "The Delphi Report". [13]

Synthesis-directed cognitive processes support and are generated in science education, especially in Mathematics and Formal Sciences. There is no proof with no synthesis. How anyone can teach a proof without presenting it? How can be presented if not by synthesis? How could it be any education, including mere instruction, with no presentation of proofs? How it is expected from the students to handle real-life problems; which, by nature, are multi-disciplinary one with no cognitive shill to relate and synthesize different knowledge obtained from different disciplines where synthesis is oriented to the solution of the real-life problems, including research, educational, professional, existential, social, and even familiar and personal problems?

Education and meta-education (including self-education) necessarily require cognitive skills for making adequate relationships, hence synthesis, and this in turn requires the cognitive skills of translating between different semiotic systems. A necessary condition for any translation is the skill to construct, synthesize, in the targeted semiotic systems, including other disciplinary semiotic systems and common language, which is the language of patients, clients, users, students, colleagues, etc.

In the context of the above-mentioned dimension of Semiotics of Mathematics Education, any communication of disciplinary research oriented to a multi-disciplinary audience is an educational process, where academics and researchers from one discipline are teaching academics/researcher/professionals in other

[13] An executive summary on this report can be found in (Facione, 1990)

disciplines. Academics from a discipline are informing academics from others, as Robert Hammond would say (Experts Informing Experts, 2017), and often themselves learning through the effort of making the translation. Consequently, inter-disciplinary communication processes, in face-to-face or virtual groups, are necessarily collaborative educational processes; these, in turn, are among the main means of meta-education, i.e., education in real educational processes where education is not reduced to one of its means, as it is the case, for example, of instruction.[14] An adequate education necessarily requires an effective translation between disciplinary and natural language semiotic systems, at the three semiotic levels: the syntactic, the semantic, and the pragmatic levels. Likewise, in the translation required for inter-disciplinary Communication. Consequently, effective educators in Higher Education should be well trained to make the additional intellectual effort required to translate between disciplinary and inter-disciplinary semiotic systems.

This semiotic translation requires an additional act of creativity, which adds to the originality required by disciplinary research. *Originality requires creativity, but creativity does not necessarily require originality.* Reverse Engineering is one of the many examples of a high degree of creativity with no originality, because it does not originate new products. Interpretations of scientific experiments require creativity but not necessarily originality, unless they end up in a new experiment that leads to new knowledge. Translation between semiotic systems necessarily requires understanding in a Semiotic System A, in order to make the intellectual interpretation required for a semiotic construction in the semiotic system B. Both interpretation and construction are creative acts. Consequently, *an author whose disciplinary article has already been peer-reviewed in the respective discipline requires an additional creative act to translate it for inter-disciplinary communication.* This means that this article is both: 1) more rigorous, because of what we explained above and 2) more creative when it is delivered for inter-disciplinary communication.

More rarely, the translation and the creativity may occur in the other direction. It may be useful or interesting to translate and generalize results of an article in one discipline or even from an interdisciplinary project using a general discipline (Situation B) into the idiom of that general discipline. For example, social science research may use graph theory to model relationships, so in a sense already be interdisciplinary, and

[14] A detailed differentiation between Higher Education and Higher Instruction has been posted at (Callaos N. , Higher Education or Higher instruction?, 2015)

observed properties of those models might generalize to interesting (and rigorous) mathematical results. This can give rise to another virtuous feed-forward cycle, with the disciplinary results now available for further interdisciplinary work.

Consequently, why this kind of articles should not be appreciated in the academic systems for granting tenure and promotion? Why is it that "Interdisciplinary work is often attacked for lacking rigor", as Julie Thompson Klein (1990) affirms? Does not this unjustified academic belief increase the probability of intra-disciplinary inbreeding and other forms of academic incest? Is not that worse than the so-called academic incest when a student takes his/her undergraduate degree, Master's and PhD at the same university—especially if these studies are almost entirely inter-disciplinary? Is not that worse than when the so-called academic incest when a PhD holder teaches in the same university or department in which he/she earned his/her PhD? Moreover, would not this have a narrowing influence on that individual's teaching, and his/her relationship with peers outside the department?

Similar remarks apply to the researcher who is not in the professoriate. Almost every field now interacts with technology and data science, and has significant ethical, philosophical, and social concerns beyond the researcher's own discipline, to the extent that it becomes a social, moral, and professional responsibility to develop an interdisciplinary perspective. This topic requires another article oriented to desirable and, even, necessary (in some situations) of ***cybernetic relationships between disciplinary and inter-disciplinary***.[15] Some of these cybernetic loops are co-regulative (via negative feedback or feed-forward) and some co-amplificatory and, hence, synergistic loops (via positive feedback).

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# Unedited notes on interdisciplinary communications: Historical perspective, rigor and current situation

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Rene Descartes (1637/1912) is the early-modern reason for scholars to miniaturize information. In 1637, he wrote that to understand anything, we need ". . . to divide each of the difficulties under examination into as many parts as possible, and as might be necessary for its adequate solution. (Ibid., p. 15) . . . by showing we cannot conceive body unless as divisible" (Ibid., p. 76). Conception perforce implies subdivision. In modern terms, our knowledge space can be reduced at least to a size of $1.61619926 \times 10^{-35}$ meters, Planck scale. We can describe anything with Planck-scale granularity, a single "particle" related to the next, then in groups. This is called "reductionism". The universe is information, "particles", a collection of zeros and ones, hence discrete.

We also classify our findings by taxonomies. Descartes was standing on ancients' ground, with Aristotle and his *Physica* dividing up the natural world. From particularization, the familiar story about the Tower of Babel had people babbling to one another in a cacophony of languages. With the explosion of scientific and technological development corresponding to the unfolding Industrial Revolution, people were having increasing difficulty making themselves understood. Now, it is even worse with persons within the same discipline unable to comprehend the other's findings.

Gottfried Leibniz (1646-1716) with his *characteristica universalis* was a forerunner of those wanting to universalize knowledge by making it intelligible enough for sharing. A milestone was reached with August Comte saying:

> As a result of this discussion [survey of fields of study], positive philosophy is thus naturally divided into five fundamental sciences, the succession of which is determined by a necessary and invariable subordination, founded, independently of any hypothetical opinion, on the mere comparison of the corresponding phenomena: These are Astronomy, physics, chemistry, physiology, and finally social physics. This classification presents the most remarkable property of marking exactly the relative perfection of the different sciences, which consists

> essentially in the degree of precision of knowledge, and in their more or less intimate co-ordination (Comte, 1830, p. 31)

Further, “The object of all true Philosophy is to frame a system which shall present a systematic view comprehend human life under every aspect, of human life, social as well as individual” (Comte, 1848/1908, p. 8). Comte was one of many thinkers of the Romantic Period who viewed nature and humanity in an interconnected way, the former imparting organicity to the latter. In many ways, 19th century peoples were reacting to the particularity of mechanization with its "soulless" machines brought on by the Industrial Revolution. Thomas Marlowe, one of the co-authors, of the introductory article above, commented Alexander von Humboldt, gentleman-scholar polymath and the Industrial Age scientist, was a strong believer in the interaction between the sciences, including the social sciences. In the same tradition, August Comte, credited as the founder of sociology (originally called “social physics” (Comte, 1830, p. 9) said, “The student will now coordinate all of his previous knowledge in by the direct study of Sociology, statically and dynamically viewed” (Comte, 1848/1908, p. 188).

Rousseau, Hegel, Bluntschli, Saint-Simon, Durkheim, and Spengler represented the trend towards organic (wholistic) thinking. The linear, lifeless model of the world espoused by the likes of Descartes and the Industrial Revolution, superseded by the 19th century, was again to undergo a crisis from which it never has recovered – Einsteinian physics and Heisenberg uncertainty. Even Einstein was to remark God “does not throw dice” (Born, 1971). Yet, a new age of *angst* has emerged, scientists wondering where and how their findings will fit into the grand scheme of things. Without data, I do still see a dialectic between two groups, those (the individuals) retreating into the corners of specialty (a world they are most familiar and can feel secure) and those (the whole) who realize to face new realities they have to come together, communicate, and collaborate. A lot of us now are quite familiar with overspecialization obstructing communication, a prime motivator for this set of articles. What of those with community consciousness?

Herein is the core of humanity collectively seeking the truth, each person affirming her/his truth through collective humanity and humanity expressed by each individual. Buddhism has a similar scheme of individual egos in the “next life” merging with the Universal Consciousness, this consciousness expresses itself by the means of individuals. I think of a bubbling soup, every bubble as an individual with a transient life but the soup outlasting everyone. When entropy takes its final toll, the soup will cool down, all individuals having lived and an integral a part of it. How, then, does the individual come to grips with this planet?

Let's take a page from Plato regarding truth (reality) outside ourselves. It is problematical at best whether we can step outside of ourselves (our cave) to observe “the truth”. In this vein, I like to think of Nick Bostrom (2003) and Daniel Canarutto (2011) speculating on our existence as a simulation run by an entity external to us. How do you step outside of this? Think of the implication of a subject in a virtual reality program telling he programmer to "take this job and shove it", as might happen in the popular 1999 movie *The Matrix*.

Reading Edwin Abbott's 1884 *Flatland* will suggest why we may never know in our lifetimes the "absolute" truth. It is a dimensionality problem. In the same way, two-dimensional beings cannot know experientially how and why a raindrop falls from the top to the bottom of their world;. We as four-dimensional beings cannot look at ourselves except through ourselves. (As an aside, mathematicians may think they understand a higher dimension by modeling it with lower dimensions, but this is not the same as experiencing it.) Even if there were something telling us the truth or if the truth simply “sat there”, we still would apprehend it in the same limited way. Nevertheless, we want to observe our dimension as keenly as our resources allow.

Ideal rigor will guarantee the truth. Of course, we should ask, "what is rigorous?" Assuming we know, another conundrum arises. Truth supposedly is everlasting, but we surely experience entropy, and such is everlasting, as well. It seems we have a contradiction, truth canceling itself out. Rather than contemplating the everlasting, the more immediate seems more manageable.
We can settle for philosophers' criteria for objectivity – coherence, correspondence, and consensus. Peer review is supposed to follow this idea with blind reviews. I won't get into the problems of peer review, but suffice it to say, it is another ideal contributing to “truth distribution”. The criteria are human-centered, and such is bootstrapping, again, finding truth through ourselves. Scientists look to independent discovery of the same phenomena, but collective bootstrapping has the same ontological status as individual bootstrapping – humans apprehending themselves through themselves. Be reminded logic and mathematics bootstrap. If there be any doubt, question the origin of axioms, rules, and definitions in deductive arguments. Inductive methods merely give probable conclusions, but this does not prevent us from using them to explore further. Think of a craft in deep space, the occupants unable to view any heavenly bodies – just "blank" space. Yet, this does not prevent establishing a reference frame to gauge observations.

Statisticians are keenly aware of their induction, the conclusion following only probably (not certainly) from the premises. Eye physiology lends itself to interdisciplinary philosophy, as the rod and cone assembly grabs a photon from our visual panorama, sends it to the rod and cone assembly, with an electron bumped out of an atomic shell, thus activating the synapse to send a signal to the brain for processing. No single rod and cone assembly is sufficient, but millions of them are, one after the other taking a sample to be processed by the brain to give us the entire picture. Newsprint is like this, with dots playing their parts to help present the everything. Survey research – in fact, statistics - is based on the principle of extrapolating a whole from samples. In all these cases, the more the samples, the closer the result comes to describing the object of inquiry. Now, look at the gazillions of fields of study, their specialized domains. One domain, like a single rod and cone assembly does not capture totality, but the collection of them places us closer to knowing more about our world.

Now, let's return to Comte for a second. An area of endeavor is related to the others, and if these allegorical assemblies of rod and cone structures are to function, they have to communicate with one another via the brain. The more disciplines the greater integrity will there be in apprehending our world. As an aside, there are physical reasons we never will be able to apprehend everything (as in digitized space and interstices simply unknown) – perhaps another aspect of our never able to leave our cave. We never will know THE truth (something in its entirety).

Let me draw another analogy – language, itself. Starting with the imperfection of a word at best a mapping of a symbol and its utterance to an idea, we look at the web of words relied upon to describe our world. This web by its very nature invokes an interdisciplinary regime, “interdisciplinary” assuming a more generic meaning of interdependence. Every single word can be defined by others. For example, "blue cows eat grass." Each word has a set of others. Look up the definition of “blue”, "cows", "eat", and "grass". In turn, each of those words has a definition. Some word search paths (like "blue") will take you to optics, angstrom units, and so forth. Oh wait, you have to do the same thing for “cows”. Then, it is “eat”, and so forth. You have an exponential task ahead of you, but we do it every day effortlessly.

Hands clapping is another aspect of interdisciplinary thinking, albeit a real basic one. No sound is produced by one hand, save, perhaps, for the rushing of air. Even air – for it to rush – must have something else to make it rush, as in a temperature and pressure differential.

Unity of difference is one way of characterizing interdisciplinary thinking. A stark example is the unity of opposites, impossible to think of an individual without an accompanying property and vice versa. In the phenomenal world, difference is essential. Try seeing anything in a room with identically-colored, shaded, and textured objects. Given the physical necessity of interdisciplinary thinking and its ability to provide rigor (the tendency to give a better idea of the whole), how do we stand in the process? Another watchword of interdisciplinary thinking is "context", viewing something in terms of that around it (language, dialectics, and statistics), as as well as becoming – something a product of the past, i.e., history, how it came to be. I used to ask my students, "where did that [object[ come from?" After the usual answers referring to various stores, gifts, etc., I took them back to the mines, oceans, and primarily, the social relations of production and distribution. Without a miner, your automobile would not exist.

We see lots of interdisciplinary signs around us in academia. Most graduate schools require at least one member of the dissertation committee be from another department. Look under "interdisciplinary conferences" and many entries will appear. We have project-oriented teaching; students will work on a larger problem necessarily incorporating numerous disciplines. Decent peer reviewing always will include a reviewer not specialized in the area discussed by the presentation/paper. Today, we are seeing more attention paid to the need for interdisciplinary communications, as in encounter groups.

Diversity movements reflect the view that strength comes because of difference. From Plato's dialogues and Aristotle's dialogic through extended and formal efforts to promote interdisciplinary approaches to communication and learning we can be more oriented toward process and organic learning, an affirmation of life, itself.

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# Interdisciplinary Communication as a Process and an Outcome: the case of Transdisciplinary Research

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***Abstract***

*This short essay looks at interdisciplinary communication as a part of transdisciplinary research. I first give some context to the essay by explaining what transdisciplinary research is and how it is an effective manner for promoting sustainable development. In this essay, I frame interdisciplinary communication as both a process and an outcome, which helps integrate the concepts of transdisciplinary research and interdisciplinary communication. I also present some of the more tenacious challenges to interdisciplinary communication in a research setting.*

Sustainable development is a goal many societies aim for in one degree or another. For my university, promoting sustainable development is a key strategic goal. In the business faculty where I teach, we are committed to helping local and regional organizations to learn how to make sustainable development financially viable by working together with them on sustainability-orientated innovation in a research setting. Sustainability-orientated innovation, briefly defined here as 'innovation aimed at creating sustainable products and services' (Foxon & Pearson, 2008) is about creation processes in which technologies, institutions, directions of investment and the exploitation of resources are made consistent with present and future needs. Sustainability-orientated innovation (SOI from now on) is in itself technically complex in that it takes place in high-pressure markets with many unknown variables such as future needs and limited resources. Adding to the technical complexity is the social aspect of innovation, where individuals' interactions are contingent on numerous contextual factors and can be highly unpredictable. The point is that SOI is in itself a highly complex process that tries to solve a highly complex problem. Because of this complexity, collaboration among individuals from different academic disciplines as well as non-academics is crucial for successful SOI or solving sustainability related issues. Collaboration among academics and professional during each step of the research process is a key trait of transdisciplinary research and directly related to interdisciplinary communication. In figure 1 below, the notions of complexity and stakeholder diversity are shown. The graph shows that as the complexity of a problem increases, stakeholder diversity increases and the type of research that is effective for solving the problem also changes.

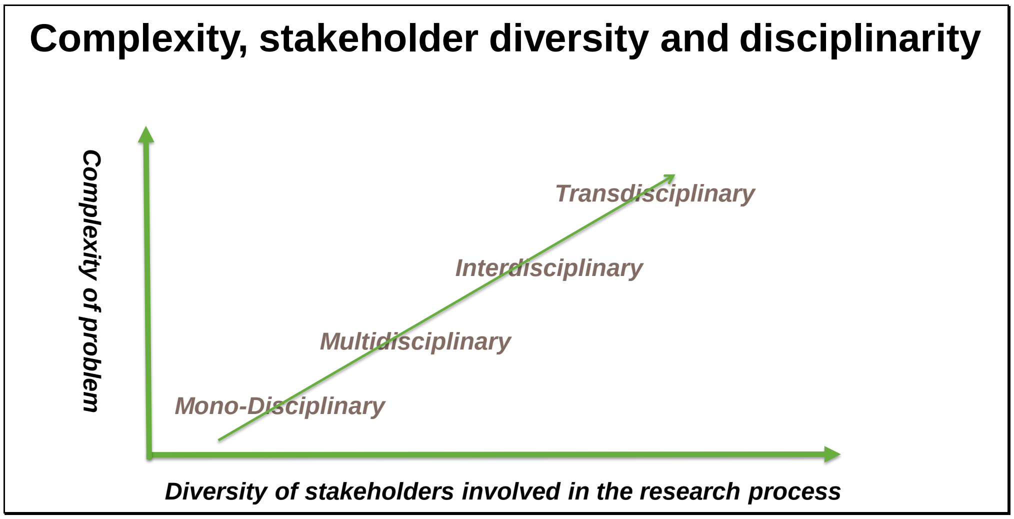


**Figure 1: Complexity and different research approaches**

Looking at interdisciplinary communication from a process viewpoint, it can be defined as the interaction among individuals from different academic disciplines. For example during a research project focused on SOI. However, interdisciplinary communication can also be conceptualized as a result of an interaction, for example some type of research artifact. In regards to interaction, communicating across disciplines can be very challenging for researchers.

If we look at the etymology we see that the term 'discipline' originates from the Latin words *discipulus*, which means pupil, and *disciplina*, which as a noun means teaching. As a verb, discipline means training someone to follow a rigorous set of instructions, but it also means punishing and enforcing obedience. Disciplinary boundaries exist because they create some coherence in terms of theories, concepts and methods that allow the testing and validation of a hypothesis according to agreed rules. These rules are different from discipline to discipline, making them to some extent incompatible. Thus, communicating with others from a different academic discipline necessitates the crossing of borders, which can only be done when there is some sort of common ground regarding theories, methodologies and discipline - specific discourses.

Crossing these borders bring individuals into new situations where they are out of equilibrium. In order to regain equilibrium, individuals will need to adapt and learn by integrating new knowledge from other disciplines. Transdisciplinary research takes this a step further by requiring individuals to also integrate new knowledge from actors from outside the university.

Interdisciplinary communication as an outcome of interaction in a transdisciplinary research setting can take on different forms that comprise various and differing types of knowledge. This includes 1) declarative knowledge (*épistémè),* which is about the current state of the system, and can take the form of new testable hypothesis or contributions to theory 2) transformative knowledge (*praxis or poïesis)*, which considers what the innovation should achieve and could be embodied in new products, services or policy insights and 3) transformational knowledge (*phronēsis)*. This is knowledge about the socio-technical aspects of innovation and how to actually bring it to fruition. The main barrier to interdisciplinary communication in regards to outcomes has to do with these different types of resulting knowledge and whether or not they are produced in a rigorous manner. Because transdisciplinary research necessarily crosses methodological borders, new knowledge claims can be seen as less rigorous than those resulting from mono-disciplinary studies. It is for this reason there is an academic focus on *intra*-disciplinary communication aimed at producing highly rigorous declarative knowledge. In fact, procedural knowledge, i.e. *praxis*, is not recognized in academia as having place in science, but belonging to the realm of the arts.

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# Collaboratively Designing for Learning

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In a Design for Learning approach, there is a need for the participants to be collaborative and creative in the design process, but it can be a challenge to facilitate this kind of processes and activities. To effectively meet this challenge requires more rigor than required by individual designs because it has to meet the usual rigor in design plus 1) the rigor of being effective collaboratively with the group of participants and 2) to effectively add group creativity techniques (e.g. synectics) to individual creativity techniques. It is important to notice that the more objectives and/or the more restrictions (or rules) to be met in the design, the more rigorous is the required thinking.

Furthermore, to adequately manage a collaborative and creative process, it demands knowledge in ways to handle interdisciplinarity, dialogue and conversations based on diverse interests, and the ability to establish a shared language among participants. To enrich the learning design output and the learning design process, participants will be invited from different domains like educators, developers, technology people, and if possible management. All of them invited to design for learning in an interdisciplinary setting. This interdisciplinary diversity in participants enhance and enrich the learning design using negotiation of meaning (Wenger, 1998), collaboration (Georgsen & Nyvang, 2007), and creative design processes (Conole, Galley, & Culver, 2011). An interesting approach would be to unfold the way in which these three parameters (collaboration, communication, and interdisciplinarity) affect the learning design process. This will be based on one of the case studies described in “Designing for Learning in an Interdisciplinary Education Context” by Buus et al. (2019). Taking these perspectives into account, when dealing with learning design, it can also be seen in parallel to the characteristics of interdisciplinary communication, as Callaos and Horne (2013, s. 28) describes them. All of these require even more rigor in thinking and doing, because there are more objective to meet and potentially more restriction to frame the design process.

Facilitating this kind of collaborative processes can be underpinned by an action learning approach, which will generate iterations based on the dialog and feedback from the participants and users. This approach also underpins the need for rigor interdisciplinary communication in design processes.

A way to see this illustrates figure 1, as a possibility to have loops and iterations in the learning design process. In this process, it will be essential to have dialogue and feedback to be able to handle and adjust to the learning design. Therefore, it becomes important to facilitate collaboration and the interdisciplinarity to enrich the output of the learning design process. What can be added is that any individual thinking requires internal communication, group thinking requires external communication, which therefore has more restrictions, e.g., a need to negotiate meaning (Wenger, 1998), build on a shared language. Interdisciplinary communication adds more restrictions and the required learning process adds more objectives. Consequently, interdisciplinary communication oriented to collaborative and creative design adds both: restrictions/rules and objectives-to-be-met than the design made by an individual according a given discipline. Since the disciplinary requirements and standards have also to be met, then it is evident that interdisciplinary communication in the context of collaborative and creative design requires more rigorous internal and external thinking as well as more effective doing than just intradisciplinary rigorous research. The latter is a necessary condition, but it is not sufficient any more in interdisciplinary communication, let alone for interdisciplinary communication for collaborative and creative design.

It will be interesting to unfold these important aspects (communication, collaboration, and interdisciplinarity) in the design process further and compare with the characteristics of interdisciplinary communication.

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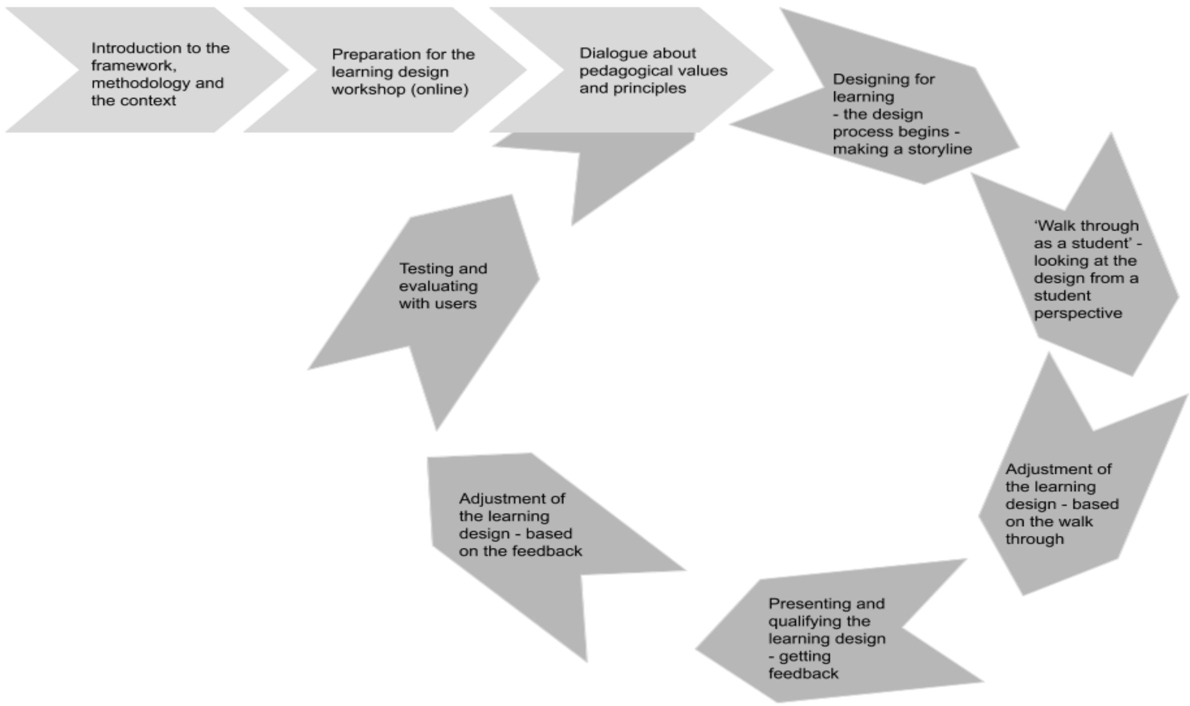


**Figure 1:** Illustrating a learning design process as an action learning approach.

# Short reflection on the outlook for E-Government in Germany with a focus on the "Rigor of Interdisciplinary Communication"

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There can be no doubt that all the staff in public administrations require new e-competences in practical aspects of e-government (Sondermann 2016; Hill 2011). However, these competences should go beyond the simple ability to make an application operable, specialist IT knowledge, and the skilled handling of IT tools (Schuppan, 2009). Studies in Germany show that the specific knowledge required for e-government to function is not adequately incorporated into the educational system, either in university courses or in advanced training programs (Lück-Schneider & Schuppan, 2017). The educational landscape in e-government is highly fragmented (Becker et al., 2016). In a study from 2014, 53 percent of administration-related programs did not refer to to e-government (IfG.CC, 2014). The relevant courses in business computing and law connected with e-government deal with the digitization of administration as a "niche topic," and training at the advanced or postgraduate level also teach different competences, mostly with a legal focus (Becker et al., 2016).

If e-government is covered in individual courses, it is often treated as a supplementary topic and is not adequately linked to strategic reform issues or related in any depth to the potential and functions of IT (Lück-Schneider & Schuppan, 2017). Where e-government is the focus of study, IT solutions take center stage in what are essentially computer science courses, so that it is not clear to what extent IT solutions and administrative functions are related to one other (Lück-Schneider & Schuppan, 2017). Issues connected with IT design, organization, and law are **not** linked, and IT is thus **not** addressed in the context of administrative modernization or state transformation (Lück-Schneider & Schuppan, 2017). In order to interlink computer science and administrative content, interdisciplinary perspectives must first be developed. If the content orientation of study programs is to reflect cultural change and modernization projects, then interdisciplinary ways of thinking and working in education and/or courses of study are essential and must be given intensive support (Lück-Schneider & Schuppan, 2017). Schuppan's competence studies in Germany (2009) showed that there is a demand not only for new specialist competences but also for skills such as the innovative faculty of abstraction, networked thinking, and interdisciplinary cooperation, suggesting that mixed competencies are necessary (Schuppan, 2009).

However, to date, there has been little scientific discussion between the realms of academia and practice on the subject of these new competences (Schuppan, 2009). Moreover, Schuppan's investigations (2009) showed that skills for self-organization and self-reflection are increasingly required at both the implementation and management level. This will require a reorientation of staff and the training of specific skills in all fields, which is also reflected in calls to adapt general nontechnical management curricula (Lück-Schneider & Schuppan, 2017). We should change our approach to teaching by discussing and evaluating questions, problems, and interpretations through the lens of different disciplines. We know that. Why do **not** we do it?

In a lecture, several professors or lecturers from different disciplines would have to deal with the selected topic at the same time. We **don't** do it, because interdisciplinary teaching is complex and cost-intensive in an age when the focus is on experts with silo thinking. In Germany, a so-called curriculum standard (CNW) has existed since 1977 as a definition of how many hours of teaching, exercises, and support are required for the training of a student in a particular study program at universities. The higher the standard of the curriculum, the more staff are needed on the degree program per student (see Erdfelder, 2007). This type of interdisciplinary learning is simply too expensive. Real interdisciplinary teaching is not provided. Alternatively, several lecturers could quickly agree on one topic and tackle it from different angles. Although this would not constitute "teaching in tandem" per se, it would be cheaper—however, it contradicts the constitutionally guaranteed freedom of research and teaching.

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# *Reflections on Inter-disciplinary Communications - Metaperspectives; Exploring the Affective Domain*[1]

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***Abstract***

*Innovation and/or research performed by Inter, Cross, and Trans disciplinary teams requires individuals to develop an understanding of how their discipline relates to other disciplines. Such understanding is obtained primarily by effective verbal, non-verbal, and written communications. However, due to each domain's institutional and psychological complexities, gaining adequate understandings of multiple disciplines can be problematic and at times seemingly impossible. This can lead to failures of the intents and goals of Inter, Cross, and Trans disciplinary teams. This reflection paper will propose an approach to ease gaining of understanding between individuals from different disciplines in an affective domain context, and possibly lay a foundation for applying affective domain rigor to how understanding between individuals occurs over time.*

*Keywords—metaperspective, attitudes, beliefs, values, Interdisciplanary, Crossdisciplanary, Transdisciplanary, communication, Interdisciplinarian, Intradisciplinarian, Semiotic System, affective domain*

## 1. Introduction

Although this reflection paper can relate to the concepts of Interdisciplinary, Crossdisciplinary, Transdisciplinary, for brevity, only the concept of Interdisciplinary is discussed.

In Julie Thompson Klein's book *Interdisciplinarity: history, theory, and practice* (Klein, 1990) "Interdisciplinarity has been variously defined in this century: as a methodology, a concept, a process, a way of thinking, a philosophy, and a reflexive ideology." In the book, interdisciplinary uses include: "a means of solving problems and answering questions that cannot be satisfactorily addressed using single methods or approaches. Whether the context is a short-range instrumentality or a long-range reconceptualization of epistemology, the concept represents an important attempt to define and establish common ground." The representation of interdisciplinary as an "important attempt to define and establish common ground", infers the use of effective

[1] This article is a second edition of (Peoples, 2019)

communication processes such as verbal, non-verbal, or written communications between individuals, also known as Interdisciplinarians, in establishing common ground understandings between their respective disciplines.

Based on the premise of Interdisciplinary need to establish common ground understandings between their respective disciplines, a closer look at how understandings are accomplished is warranted. Interdisciplinary understandings begin with an individual discipline-based field of knowledge. This knowledge is formed by Intradisciplinary communications by Intradisciplinarians within a specific discipline. In forming a knowledgebase utilizing Intradisciplinary communications, a system of concepts, the symbols representing the concepts, and the relationships between the concepts forms and evolves over time. As a domain knowledgebase evolves, a bias unique to discipline is established, reflecting how the knowledgebase forms unique agreed upon meanings of existing concepts, and generation of additional concepts, symbols, and relationships. These biases usually take the form of attitudes, beliefs, and values toward the concepts, symbols used to represent concepts, and relationships between the concepts contained in the existing and evolving knowledgebase.

In studying the evolvement of a domain knowledgebase, the field of Semiotics emerged. In the article *Elements of Semiotics*, Prof. Louis Hébert of the Université du Québec à Rimouski, describes Semiotics as “the field of study that is concerned with signs and/or signification (the process of creating meaning).” (Hébert, 2019). It can be argued when Semiotic techniques identified by a disicpline are implemented by Intradisciplinary communications, a unique Disciplinary Semiotic System is formed (Callaos & Marlowe, 2020). Inherent to the Disciplinary Semiotic System are the attitude, belief, and value biases formed by Intradisciplinarian communications. It can be argued these attitudes, beliefs, and values form perspectives unique to a discipline, a reflection of the affective domain of a discipline.

When Interdisciplinary teams are formed, one of the greatest obstacles to the team’s success is establishment of common grounds. Key in the establishment of common grounds are translations between the Disciplinary Semiotic Systems of the unique disciplines involved in the Interdisciplinary team. Translations between the Disciplinary Semiotic Systems involved are usually accomplished by *effective* communication between Interdisciplinarians representing their respective disciplines. The communication process can be fraught with misunderstandings between Interdisciplinarians during, or as a result of communication processes. What seems to be missing in the translations of Disciplinary Semiotic Systems are the inherent attitude, belief, and value perspectives of the concepts, the symbols representing the concepts, and the relationships between the concepts when communicating content from one Interdisciplinarian’s knowledgebase to another Interdisciplinarian from another unique discipline. A methodology is needed to allow the communication process measure inherent attitudes, beliefs and values of a concept from a sender's viewpoint (Interdisciplinarian team member from a unique discipline) to a receiver's (Intradisciplinarian team member from another unique discipline) in a manner where the sender's view of the receiver's viewpoint of attitudes, beliefs, and values of the concept are properly aligned in an affective domain context. In some disciplines, this conceptual methodology can be termed metaperspective. In the above contexts, this paper will introduce a theory to measure and align attitudes, beliefs, and values between Disciplinary Semiotic Systems in obtaining metaperspective in an affective domain context.

## 2. Basic Theoretical Methodology

This theoretical computational methodology to measure metaperspective in an attitude, belief, and value context is based on the work of Martin Fishbein's measuring beliefs as applied to attitudes (Littlejohn, 1983, pp. 142-144), and on the work of Milton Rokeach's utilization of attitudes, beliefs and values to measure the change of a person's behavior and self -regard (Littlejohn, 1983, pp. 151-157).

### A. *Base Algorithm*

A computational based algorithm is required to capture an individual's attitude, belief and value affective domain perspective on a concept, including the concept itself, a symbol used to represent the concept, or concept relationships.

$$\boldsymbol{P_0} = \sum \boldsymbol{A\,B\,V}$$

Where $P_0$ = The person's perspective of Concept 0

$\boldsymbol{A}$ = Attitude: the person's attitude of a concept (Attitude in this context is defined as a

predisposition to act positive or negative towards the concept)

$\boldsymbol{B}$ = Belief: the person's belief the attitude towards the concept is true

$\boldsymbol{V}$ = Value: the person's degree of importance placed on the concept

Please note there may be multiple (N) number of separate ABV observations for an individual concept.

### B. *Obtain Data for Algorithm*

To obtain data for the algorithm, a series of Likert scale questions and answers based on attitudes, beliefs, and values for the concept is generated. The answers to attitude, belief and value questions would be pre-determined with a numerical value assigned to each answer. For example, for each question, an implementer may provide 5 answers. Each answer would be assigned a number, in this case 1-5. The numbers assigned to each answer given would be summed, resulting in a number representing a person's attitude, belief, and value perspective for a concept under consideration, $\boldsymbol{P_0}$ .

**C. Expansion *of the Base Algorithm for Interdisciplinarian Team Use***

To compute metaperspective to reflect obtaining common ground understandings of attitude, belief, and value affective domain perspectives for concepts in a communication process within an Interdisciplinary environment, the base algorithm must be slightly expanded and modified.

$$\boldsymbol{SP_0} = \left(\sum \boldsymbol{A\,B\,V}\right)_{\boldsymbol{x}} = \boldsymbol{RP_0} = \left(\sum \boldsymbol{A\,B\,V}\right)_{\boldsymbol{y}}$$

Where $SP_0$ = The sender's perspective of Concept 0

$A$ = Attitude: the sender's attitude of a concept (Attitude in this context is defined as a predisposition to act in a positive or negativeway toward the concept)

$B$ = Belief: the sender's belief the attitude towards the concept is true

$V$ = Value: the sender's degree of importance placed on the concept

$x$ = Sender's discipline

Where $RP_0$ = The receiver's perspective of Concept 0

$A$ = Attitude: the receiver's attitude of a concept (Attitude in this context is defined as a predisposition to act in a positive or negative way toward the concept)

$B$ = Belief: the receiver's belief the attitude towards the concept is true

$V$ = Value: the receiver's degree of importance placed on the concept

$y$ = Receiver's discipline $SP_0$

$\boldsymbol{SP_0}$ and $\boldsymbol{RP_0}$ are necessary for the algorithm to accurately identify the sender's and receiver's attitude, belief and value affective domain perspectives for a concept under consideration in an Interdisciplinary communication process. This allows the communication process measure inherent attitudes, beliefs and values of a concept from a sender's viewpoint (Interdisciplinarian team member from a unique discipline) to a receiver's (Interdisciplinarian team member from a another unique discipline), in a manner where the sender's view of the receiver's viewpoint of attitudes, beliefs, and values of the concept are properly aligned in obtaining "common ground" in an affective domain context. Using evaluative techniques in D. Evaluation of Data, it is theorized a form of metaperspective can be achieved in an affective domain context.

Subscripts $x$ and $y$ are added to clearly identify the sender's and receiver's domain. Having this type of domain information can be useful in long term pattern analysis for the effectiveness of the communication process used to obtain common ground, and to identify potential domain conflicts over time. If identified, future potential conflicts between domains may be identified and planned for during Interdisciplinary team interactions.

**D.** ***Evaluation of Data***

Using techniques for obtaining data described in sub-section "Obtain Data for Algorithm", data is collected for the sender and receiver sides of the algorithm. In a perfect world, the sums on both sides of the algorithm should be equal, indicating a sender's attitude, belief and value affective domain perspective for a concept under consideration matches the receiver's. In theory, metaperspective on gaining a common understanding for a concept under consideration in the context of the affective domain is achieved.

In the below example, a number representing a sender's attitude, belief and value perspective for a concept under consideration matches the receiver's attitude, belief and value perspective for a concept under consideration, 12. In this case, metaperspective in an affective domain context is achieved.

$$\boldsymbol{SP_0} \;=\; (\mathbf{12})_{\boldsymbol{x}} = \; \boldsymbol{RP_0} = (\mathbf{12})_{\boldsymbol{y}}$$

In reality, it is expected the sum on both sides of the algorithm will be different for the first communication attempt. In the example below, the number representing a sender's attitude, belief and value perspective for a concept under consideration is 12, while the receiver's number representing attitude, belief and value perspective for a concept under consideration 0. In this extreme example, metaperspective on gaining a common understanding for a concept under consideration in the context of the affective domain is not achieved.

$$\boldsymbol{SP_0} \;=\; (\mathbf{12})_{\boldsymbol{x}} \neq \; \boldsymbol{RP_0} = (\mathbf{0})_{\boldsymbol{y}}$$

It is theorized if data is collected on the sender and receiver over time, the expected the sum on both sides of the algorithm will become closer to each other. In the below example, assuming the data is collected at 1-week intervals over 4 weeks, where numerous effective communications occur between the sender and receiver each week, as data is evaluated, the sum on both sides of the algorithm should become closer, indicating partial common ground understanding of attitude, belief and value perspectives for a concept under consideration in the context of the affective domain.

Week 1:

$$SP_0 = (12)_x \neq RP_0 = (0)_y$$

Week 2:

$$SP_0 = (12)_x \neq RP_0 = (3)_y$$

Week 3:

$$SP_0 = (12)_x \neq RP_0 = (7)_y$$

Week4:

$$SP_0 = (12)_x \neq RP_0 = (10)_y$$

It is theorized the sum on both sides of the algorithm will rarely be equal. That being said, data collected over a longer period of times in the contexts of *x*, and *y*, and in the context of the concept under consideration, patterns emerge indicating a range of numerical “closeness” for sums between both the sender and receiver. For example, in the domains of Mathematics and Biology, a 4 may be the acceptable range for obtaining a partial common ground understanding of attitude, belief and value perspectives for a concept under consideration in the context of the affective domain.

$$SP_0 = (12)_{Mathmatics} \sim RP_0 = (8)_{Neuroscience}$$

It should be noted in all of the above examples, metaperspective is achieved by the sender and receiver. By having the sum data on both sides of the algorithm, the sender’s view of the receiver’s viewpoint of attitudes, beliefs, and values of the concept become known, and vice versa. Using this knowledge, the sender and receiver can explore communication options to better understand differing viewpoints in the context of the affective domain, and as a result, gain a better understanding of both common ground, and uncommon ground.

## 3. *Conclusions*

In our increasingly complex world, one of the potential problems of gaining “common ground” understanding between 2 individuals is ignoring the affective domain. The proposed methodology is conceived to address the affective domain aspects of identifying and creating “common ground” between Interdisciplinary, Crossdisciplinary, and Transdisciplinary, team members as innovation or research occurs. The methodology is conceived to allow the communication process measure inherent attitudes, beliefs, and values of a concept from a sender’s viewpoint and a receiver’s viewpoint, in a manner where the sender’s view of the receiver’s viewpoint of attitudes, beliefs, and values of the concept is properly identified in an affective domain context. In the situations where teams create new products or knowledge, the proposed methodology can be used to identify affective domain aspects of the attitude, belief, and value perspectives for newly generated concepts, symbols representing newly generated concepts, and the relationships between the existing concepts and newly generated concepts.

Additionally, the proposed methodology has other uses. The methodology can be used in learning, education and training situations where measurement of the affective domain is necessary. Currently, as in the past, the affective domain in learning, education, and training activities is often ignored. For an example of the propose methodologies use in the context of classroom instruction, the algorithm can be modified to reflect a teacher and a student for concepts being taught and learned:

$$\boldsymbol{Instructor\ P_0 = \left(\sum A\,B\,V\right)_x = Student\ P_0 = \left(\sum A\,B\,V\right)_y}$$

In this situation, a pretest consisting of a series of Likert scale questions and answers based on attitudes, beliefs, and values for the concept would be given. It is theorized the differences between the sums on each side of the algorithm will be large:

$$\boldsymbol{Instructor_0 = (12)_x \neq Student_0 = (0)_y}$$

At the conclusion of instruction, a post-test using the same Likert scale questions and answers is given to the student. It is theorized the sums on each side of the algorithm will become closer than the pretest:

$$\boldsymbol{Instructor_0 = (12)_x \sim Student_0 = (9)_y}$$

Although there are many other uses for the proposed methodology, research utilizing the methodology is needed to evolve and test its fitness for measuring the affective domain in determining metaperspective**.**

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# Aesthetic Communication Rigor and the Wisdom of Cybernetics

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***Abstract***

*An effective interdisciplinary communication requires aesthetic communication rigor. This rigor is fully realized in the Greek tragedy in which Apollonian order and Dionysian intoxication are integrated. The beauty of interdisciplinary communication can be found in the reflexive and reflective knowledge and wisdom of cybernetics. A loving and integrative mindset produces diversity and creates an increasing number of choices with joy in learning and active imagination. Multi-integrative interdisciplinary interaction can be expanded to the cosmic scales in a higher order. Aesthetic rigor or the language of dancing works as the cure to C. P. Snow's two culture diseases by connecting every disconnected data in informatics.*

***Keywords***: *interdisciplinary communication, aesthetic rigor, integration, cure, love, creation, beauty*

## 1. Introduction

Many theories have been established and published concerning the nature of artistic communication. Among them, John Dewey attempted to narrow the gap between the refined experience of art and daily human activities and developed an interactive model of aesthetics by focusing on dialectical processes of experiences which require both analysis and synthesis. Additionally, he emphasized the reconstructive act of the audience (Dewey, 1934, p. 121), which offered a fresh insight into the appreciation of artistic work and art education, though he never addressed the concept of "rigor". Concerning rigor, Callaos and Marlowe recently described mathematical analysis and synthesis in terms of rigor of pure mathematics and rigor of mathematics education (Callaos & Marlowe, 2000, p. 17). With a slight transformation, this perspective can be equally meaningful in art. Thus, the first part of this paper attempts to integrate Dewey's understanding of art and Callaos's and Marlowe's perspective of rigor of math/math education into a concept of aesthetic communication rigor, which may help clarify the meaning of rigor in interdisciplinary communication.

The second part of this paper is an exploration of desirable aesthetics in interdisciplinary communication. The history of cybernetics offers insights for developing an interdisciplinary aesthetic communication model. Cybernetics starts with a technical device or a way of steering physical objects. It requires rigidity to properly measure the direction of the objects including ship, missiles, or robots. Yet as steering has expanded its scope from ships to the stars, dolphins, and human organizations, both rigidity and imagination are required. A scientist who does not know love and wisdom never enters the extended field of cybernetics. Historically, bringing a creative, epistemic practices with aesthetics contributes to the field's further development, as Heinz von Forester, Gregory Bateson, Margaret Mead and other cyberneticists have developed it to a highly complex integrative theory. With the advance of second-order cybernetics, art significantly contributes to its development by suggesting an integrated vision which goes beyond the boundary of a technical control theory. Art in cybernetics emerges particularly where integration through dynamic interaction is necessary. This paper will explore the aesthetics of cybernetics and proposes "cybernetic love" and "interdisciplinary dancing" as useful terms to frame the inquiry. In this process, aesthetic rigor in interdisciplinary communication and its relationship to creativity, love, and imagination will be studied further.

## 2. Art and Aesthetic Rigor

Works of art are produced with and in life-experience of the past, which is frequently found in the deep structure of mythology including the myths of Apollo, Dionysus, and Icarus. Since its inception, art has been inseparable from the daily communal life of humanity (Dewey, 1934, p. 2). Religious festivals and rituals have especially accompanied dancing, music, and literature. Artistic creation is both intuitive and orderly, and the truth and the beauty are integrated in art. As John Keats properly expressed in his Ode, "Beauty is truth, truth beauty." Works of art are the cumulation of the myriad of interactions of all living creatures and their surroundings of the past, and these interactions require integrative rigor.

An artist's integrative rigor searches to find an aesthetic form. In the process of searching for this aesthetic form, the seemingly random experiences of the artist become systematic and structured. Diverse constituent elements of artistic materials are arranged in an ordered relationship. Individual units have dynamic relations within a structure. Nietzsche searched the integration of Apollonian rigor to make order and intoxicated ecstasy found in Dionysus in the Greek tragedy. Integrated rigor fuses harmony and disorder, clarity and intoxication, and logic and intuition, all of which are crucial in creating works of art (Nietzsche, 1872, p. 33). The final form of the artist glorifies the birth of a new creative artistic piece. As Matisse proclaims, when a painting is finished, it is like a new-born child.

One significant artistic rigor is imaginative; it is related to passionately imaging or dreaming a desired future (Fry, 1964, pp. 21-22). This passionate dreaming works even when it is not imaginary, as Martin Luther King's "I have a dream" speech suggests. Yet any accomplished work of art requires a proper arrangement in a purposeful and orderly relationship as an expressive unity with the precise color, tone, shade, and shape.

An appreciation of art starts with the recognition of an artist's design. This is the point where art education becomes involved. To appreciate a work of art, a rigorous analysis is necessary. Art education includes a study of artistic devices such as defamiliarization, collage, and metaphysical conceit. Art is interpreted into another semantic system and students are required to learn art through non-artistic semantics whose process is frequently rational rather than intuitive. Thus, the consequence of such an analysis is a logical translation of truth and beauty. In this setting, art is separated from our daily life and fails to be reorganized in the recipient's new social context.

The value of artistic appreciation lies in the power of restructuring what the recipient has analyzed and then integrating this restructuring into an entirely new social context. This restructuring allows art to serve for some other purposes from a recipient's perspective. The recipient simply does not accept a ready-made message provided by the artist. Art can be recreated in the receiver's context and reoriented for the future. Through the recipient's mental model in his or her social context, art is reconstructed. In this context, the appreciative behavior of art becomes active, for the recipient does not passively understand a work of art. The recipient's reorientation works as feedback, and thus, in turn, influences the artist. Diverse reviews and responses from the recipient significantly affect an artist who desires to be engaged in having a positive relationship with his or her recipients.

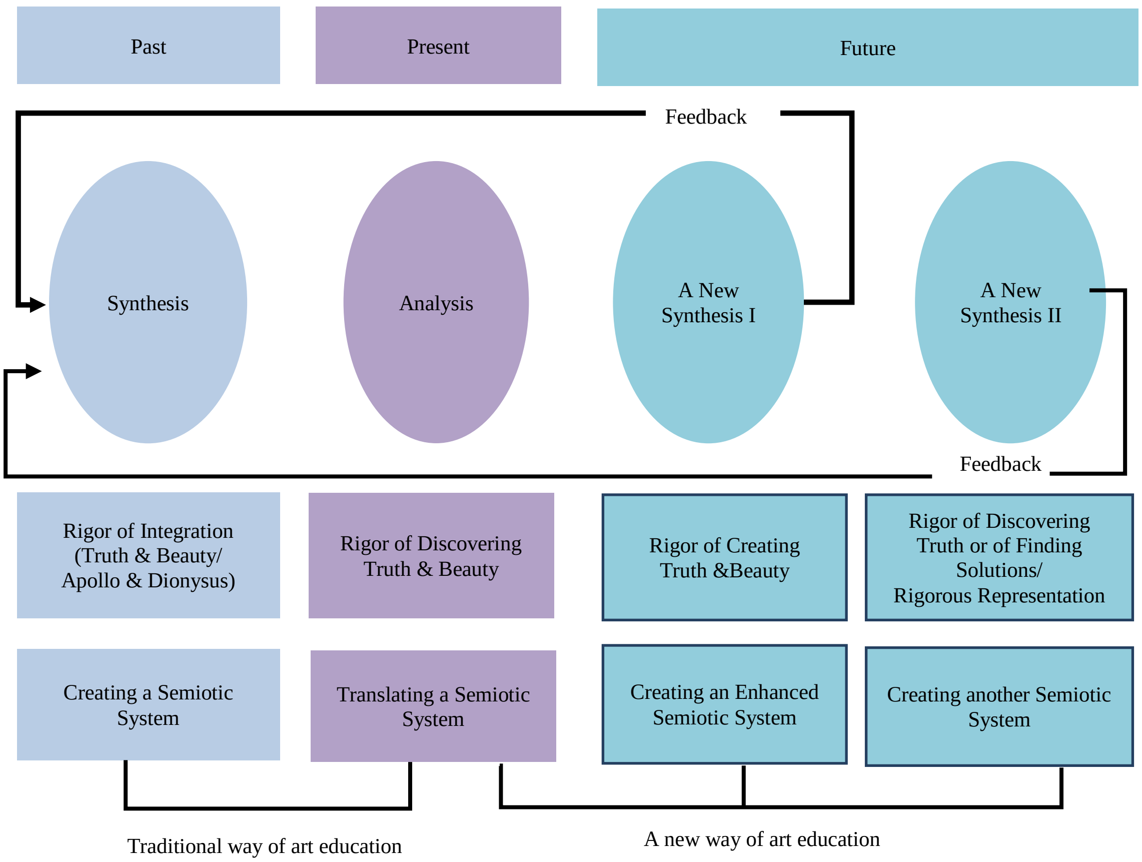
In addition, reorientation of art necessitates interdisciplinary communication. The result of communication is the production of declarative knowledge, transformative knowledge, or transformational knowledge. Pythagoras found mathematical and metaphysical principles in music. Freud found a psychodynamic principle in *Oedipus Rex*, *Hamlet*, and *Brothers Karamazov* and expressed it with another semiotic system. Art has been harnessed to generate ideas or to produce goods and services for real-life problems. In an organizational theory, art contributes to creating an emerging organization by presenting new images (Morgan, 1993, p.19). To a marketer, art is "the truly human act of creating something new that matters to another person" (Godin, 2012, p. xiii). William Gibson's cyberspace in the Neuromancer trilogy contributes to the development of three-dimensional virtual reality imaging software. Art is more than a collection of artistic devices and techniques. It is a way of living and a way of perceiving and thinking. In the process of harnessing art in their own contexts in other disciplines, a new way of thinking can be found or re-oriented through interdisciplinary communication. This synthesis, in turn, influences the artist who seeks to create a new piece of art.

A productive aesthetic interdisciplinary communication requires aesthetic literacy and rigor in finding the truth or new solutions. Other interdisciplinary communications also produce creativity. Yet, aesthetic interdisciplinary communication especially generates more creative consequences than other interdisciplinary interactions mainly because of the indeterminate features of art. Art offers more subjective interpretative space than other disciplines, and this flexibility often triggers the birth of new innovative concepts or products after interdisciplinary actions. In order to produce any meaningful innovation, clarifying a new insight in analytic terms and translating it into clear language is desirable, once gaining new insight after interacting with art. In other words, one should give more care to the representation of a new concept or a product after aesthetic interdisciplinary interactions, for the consequence of the interaction can be highly novel. To be useful, novelty requires to be rigorously managed. In the case of generating transformative knowledge or transformational knowledge, effective representation is required, as Herbert Simon points out that “solving a problem simply means representing it so as to make the solution transparent” (Simon, 1981, p. 132). Both highly rigorous representation and translation are necessary when the outcome of interaction is declarative knowledge.

## 3. Aesthetics in Cybernetics

Clear logic is an essential requirement for interdisciplinary communication. However, in and of itself, clear logic is insufficient for interdisciplinary interactions. Citing Dr. J. Bronowski’s comment, Norbert Wiener points out that the success of math should be judged both aesthetically and intellectually (Wiener, 1954, p. 95).1 Aesthetics is a part of any intellectual communication and, as such, interdisciplinary communication requires a sense of beauty and emotional intelligence.

[1] Norbert Wiener was an American mathematician whose research in stochastic and mathematical noise processes significantly contributed to the field of electronic communication, electronic engineering, and systems control. In this sense, problems of math and success of math mentioned above are not only disciplinary but also interdisciplinary.




"Integrative rigor" is essential in interdisciplinary communication. This aesthetic rigor is fully depicted in Greek art according to Nietzsche. It is the melding of Dionysian and Apollonian, the intuitive and the orderly, heart and reason, and the subjective and the objective, producing the beauty of merging contradictory values and concepts. In informatics and cybernetics, a seemingly non-subjective logical work is frequently inseparable from subjective mentality. Norbert Wiener, a pioneer of cybernetics, discussed the analogy between an unsolved scientific problem and emotional tension. A mathematical problem was so closely tied to this tension that separation was impossible (Heims, 1982, p. 155). Wiener found a difficult problem, and fell into a depression, which prompted him to devote himself to the problem. Even the most factual of all sciences has its link with emotional tension through analogy, and in this equivalency Wiener found his regained psychological homeostasis. This psychological rigor may not be easily recognizable, yet it can be traced in a seemingly non-subjective logical work.

Another constellation of aesthetic rigor addresses the issue of simplicity. The outcome of interdisciplinary interaction should be searched and represented with clarity and simplicity. Often quoted passages such as Kelly Johnson's KISS (Keep it simple, stupid), Ludwig Mies van der Rohe's "Less is More", and Leonardo da Vinci's "simplicity is the ultimate sophistication" show the principle of simplicity in disciplinary and interdisciplinary studies and practices. Yet simplicity should be realized without impairing the beauty in the complexity. Frequently, complexity is not only acceptable but also necessary. The history of informatics and cybernetics shows the necessary beauty in the complexity. During the foundational stage of cybernetics, Norbert Wiener, John von Neumann, Claude Shannon and other scholars interested in control and communication theory maintained that information is a pattern defined by the probability distribution of coding elements, not the message itself. A simple linear mindset would not have supported the proposition that information is identified with both pattern and randomness, for the opposite side of a pattern is the absence of a pattern, or randomness. The development of information theory was possible with an integrative insight that pattern and randomness merge together to be reorganized for a higher level of complexity. Occam's razor, which pursues the simplest solution, can be attractive to some engineers and designers. Yet, interdisciplinary communication often welcomes non-commonsense complex beauty.

Gordon Pask's illustration of men in bowler hats also demonstrates the beauty of complexity. A number of men in bowler hats creates an observer who is observed by another observer. The observer becomes a part of the system being observed, for feedback loops through the observer. Thus, not a single piece of information crosses the border separating the system from its environment. Without falling into solipsism, Heinz von Foerster developed the concept of reflexivity, never evading the most problematic and complex constructions in science (Foerster, 2002, p. 5). By exploring the significance of the observer in cybernetics, Von Foerster subverted the premise of Descartesian dualism and opened the second stage of cybernetics. As Donald A. Norman stated, being complex is beautiful, and simplicity is frequently not the opposite pole of complexity (Norman, 2011, p. 53). Systems thinking offers an overview of the whole structure under complex situations. Instead of having a snapshot of linear cause-effect chains, interdisciplinary aesthetics prefers complex relationships.

Aesthetic rigor is hard to conceive without the concept of creativity. As Wiener points out, the value of art as information is judged by the new perspectives that cannot be found in the works of the previous era. In the past, the motivation of interacting with the world by creative works was preserved, yet now our study becomes a matter of gaining social position by getting degrees. Easily replicable precision is preferred in (inter)disciplinary education instead of finding something new and powerful. Since there is nothing new, there is nothing to communicate. The desire to find something new to say and to discover a new way of saying are the sources of all life and interest (Wiener, 1954, p. 134). Finding a new way of saying something requires emotional intelligence, and Daniel Goleman listed initiative and change catalyst as leadership competencies with emotional intelligence (Goleman, 2002, pp. 255-256). Leaders in interdisciplinary studies need to excel in initiative, and to create new opportunities for the future. If necessary, conventional rules can be changed, as Norbert Wiener and Von Foerster challenged the status quo of their contemporary intellectual climate and attempted to probe an unprecedented synthesis of the organic and the mechanical.

Creativity requires an insightful person who has the willingness and capacity to change an existing system and produce new ideas or products. Yet creativity cannot be reduced to merely a mental activity, or an insight that occurs in the head of a special person. As Mihaly Csikszentmihalyi posited, creativity can be regarded as a co-related system of three parts: domain, field, and person (Csikszentmihalyi, 1997, p. 27). Domain is an area that consists of a set of rules and procedures. Wiener established a new domain, called Cybernetics, through interdisciplinary interactions, and Von Foerster demonstrated his insight that the observer of a system can be constructed as a system to be observed in the domain of Cybernetics. Additionally, a new domain requires gatekeepers who select and decide which idea or product will be included in a domain. The Macy conferences worked as a gatekeeper of interdisciplinary communication under the direction of Frank Fremont-Smith in New York in the mid-1920’s. Its main aim was to find a circular causal signaling loop in biology and society. Cybernetics has since expanded into fields covering robot engineering, systems control, computer engineering, electrical engineering, neurophysiology, psychology, business management, etc. In this sense, the nature of aesthetic value of interdisciplinary communication lies in relational creativity or co-creativity. In brief, creativity in interdisciplinary communication requires an insightful person. Yet creativity requires more complex systems, for interdisciplinary creativity is far more than an insight arising from a genius.

## 4. Cybernetic Love

Nagib Callaos and Thomas Marlowe say, “Intellectual Strictness requires thinking, and acting,” pointing out that communicating is a form of acting (Callaos & Marlowe, 2020, p. 6). It may be added that intellectual strictness requires feeling and acting.1

[1] “Emotion” and “Motivation” have the same root, to “move”, or to “act.” According to Adam Smith, ethics is in line with feeling, rather than reason. This sentimental ethics is fully developed by his friend,

Humberto R. Maturana insists that love is an indispensable stabilizing factor in constructing a social system, proclaiming that each individual becomes “an observer through the experience of love” (Maturana, 1928, p. xxix). From the stage of observation, communication of organization of living systems requires the emotion of love. In the recurrence of active interactions, a communicator respects the Other as a partner in the dimensions of living. The interdisciplinary interactions should be rigorously based upon love in order to establish the desirable systems in which an observer wants to live. This is why interdisciplinary communication exists.

One significant component of emotional intelligence required for interdisciplinary communication is developing the Other with empathy (Goleman, 2002, p. 256). Offering timely and constructive feedback is the core of cultivating people’s capabilities. Building knowledge through interaction for the growth of the Other is the ultimate beauty of interdisciplinary communication. Interdisciplinary communication requires a high standard of emotional rigor. The first passage in Adam Smith's *The Theory of Moral Sentiments* describes the ethics necessary for the aesthetic rigor in interdisciplinary communication: “How selfish soever man may be supposed, there are evidently some principles in his nature, which interest him in the fortune of others, and render their happiness necessary to him, though he derives nothing from it, except the pleasure seeing it” (Smith, 1759, p. 3). The future interdisciplinary interactions should be rigorously based upon empathy, or the concern for the Other. The consequence of this interaction should be not only truthful but also beautiful. The pursuit of beauty without the truth is empty, yet ruthless pursuit of the truth without the beauty is blind in interdisciplinary communication.

So long as communication means not only understanding the Other but also doing something for the Other, interdisciplinary communication should value the affective domain field. Without sharing “cultural milieu”, “personal milieu”, and “belief milieu” (Forester, 2014, p. 4), neither productive interactions nor the genesis of knowledge is possible. The affective domain matters in communication, and Heinz von Forester points out that “it is the listener who interprets an utterance” (Forester, 2014, p. 4). The significance of understanding the affective domain context is more important in practical disciplines in which the emitter of the communication wants to influence the recipient’s behavior. Peter Drucker, the father of business management, maintains “it is the recipient who communicates” in defining communication in business (Drucker, 1973, p. 262). Interdisciplinary communication requires an attention to understand the recipient’s language. Drucker also argues “most perfect communications may be purely shared experiences without any logic whatever” (Drucker, 1973, p. 265).

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David Hume. Philosophy can be divided into speculative and practical, and morality belongs to the practical area. Morality influences our passions and actions, and thus go beyond the calm and indolent area of understanding.

Effective communication requires the shared purpose, the shared experience, and the shared values. That is why the utterer of communication needs to pay attention to what the recipient expects to see and hear, and to talk in his or her terms. Respecting affective domain field and talking in the Other's terms require emotional intelligence and affective domain rigor.

The title of the first chapter of Cybernetics, or Control and Communication in the Animal and the Machine is "Newtonian and Bergsonian Time". It is a dialogue between physics and biology, and between inanimate objects and living organisms. This highly challenging and interdisciplinary chapter starts with a German "poem" instead of any proposition or principle, which implies that any mature interdisciplinary dialogue requires aesthetic values. Moreover, this poem suggests that Wiener would like to establish cybernetics as a new discipline with beauty and creativity. Recently "distributed cognition" is widely used in interdisciplinary science papers. Surely, cognition is composed of multiple agents, and crews of a ship can work as distributed machines for better navigation as Edwin Hutchins' study demonstrated (Hutchins, 1995, p. 251). This paper suggests that "distributed creativity", a coined term, can be useful in denominating an aesthetic nature of interdisciplinary communication as the art of steermanship. An internally integrated process of creating new knowledge through a series of feedbacks and cybernetic loops is underway. The focus of creative interdisciplinary communication shifts from "who has an idea" to "how to systemically generate an idea". The aesthetic point lies not in hailing a super-heroic scientist inspired by Muses, but in joining art performance in the stage of interdisciplinary studies with passion. Further, this new pattern of creating beauty and creativity should be rigorously founded upon moral sentiments as well as emotional intelligence.

Heinz von Foerster points out that "for whom do you tell it?" is not the right question in communication in cybernetics. His alternative suggestion is "with whom are you going to *dance* your story, so that your partner will float with you over the decks of your ship, will smell of salt of the ocean, will let the soul expand over the sky?" (Foerster, 2002, p. 297) [Italics added]. For co-creating activities with dialogics, a language in the sense of grammar, syntax, or semiotics is not sufficient. It needs "dance of language" (Foerster, 2002, p. 295). Dancing is a language of fascination, performance, love, and magic that cannot be explained, and its function is to extend our body. The appearance of language is monological and describing, whereas the function of language is dialogical and creating. Dialogue requires conscience, and within Other-oriented ethics, knowledge is built by knowing together(*con-scire*). The epistemology of communication may start when communicators see themselves through the eyes of the other. Yet constructive communication is impossible without the aesthetics of dancing between the communicators to expand their body and soul over the sky.

Mary Catherine Bateson's *Our Own Metaphor* has a chapter on cybernetic love, in which love is linked to "diversity". Allowing diversity despite seemingly hierarchical difference means to demonstrate the spirit of love. This love is related to the ethical imperative of Von Foerster: "Act always so as to increase the number of choices" (Foerster, 2003, p. 227). In cybernetics, love is the term that brings about the attention to relationships. Gregory Batson frequently uses the term, love, when he attempts to make a bridge between the primary process and the secondary process, or the structure of unconscious and the structure of conscious (Mary Catherine Bateson, 2005, pp. 279-280). To love means to regard myself as a system and to regard the person whom I love as systemic. In addition, it means to accept that my system and the other's system constitute a much larger system. This systemic understanding of love facilitates the expansion of love to every single creature of the universe. Western intellectual tradition tends to put the ultimate locus of value upon the person as a self-reliant individual. From individual consciousness and willful purpose, point shifts to building a composite made from dynamically related parts. Understanding love from cybernetics means accepting complexities both more and less without reductionism. Instead of focusing on increasing the amount of happiness, the relationship itself has importance.

Being in love entails a willingness to relate what the mind has captured in the way that one part is related to another part for a higher synthesis. Love is the emotional aspect of the mental state of any creature and is related to the unconscious areas of psychology. All sciences, religion, and art are integrated in beauty. Bateson attempts to show this aesthetics of a larger inclusive system in *Angels Fear*. Beauty in integrated unity is noticed by observing how each part is related to each other for a greater whole. Bateson claims that love is based upon a three-way metaphor. It links not lonely self to the Other but to self plus Other. Love evokes not only the value of self and Other, but also the value of relationship (Gregory Bateson & Mary Catherine Bateson, 2005, p. 192).

According to Ben Godrtzel, love is a hybrid supersystem composed of four subsystems: sexuality; caregiving; attachment; and intimacy. Falling in love with somebody is the convergent process of different systems and is the result of complex and non-linearly adaptive interaction between sub-systems (Goertzel, p. 316). Through dynamics of interactions, a fixed boundary can be transcended, and a meaningful pattern can emerge. One of the most remarkable examples of transcendence is overcoming Freudian romantic love. Instead of being trapped in an Oedipus complex and the following masochistic psychology, one can establish a balanced self-organizing system in which a recurrent feedback loop occurs.

Cybernetic ecology is well aligned with Abraham Maslow's "Being psychology", in which an individual integrates for the greater good. Instead of relying on self-preservation and deficiency-oriented mechanisms, cyberneticists unfold reconciliatory vision, insight, or love, generating peak experiences with awe, wonder, reverence, and even piety (Maslow, 1999, p. 92). In its culmination, a cybernetic ecologist can escape a violent and aggressive dominated mindset and respect all humans with a loving, integrative mindset. Mary Catherine Bateson began her "Diversity and Love" chapter with the passage that she enjoyed the rhythm of the day and finished it with the rhythm of the universe. Love for diversity encourages cyberneticists to discover this rhythm or harmonious structure.

## 5. Interdisciplinary Dancing

Bushman shaman dances with Gregory Bateson with polyphonic singing and clapping says, "we shall ever continue dancing together throughout eternity, being both above and below" (Keeney, 2005, p. 89). Here dancing is art of joy in interacting with the Other and building an endless circular relationship with the Other in cosmic level. In this cosmic dance, binary division is not maintained, for every single part becomes a complementary part in a broader ecosystem. As Mary Catherine Bateson points out, aesthetic unity is analogue to the "notions of systemic integration and holistic perception" (Gregory Bateson & Mary Catherine Bateson, 2005, p. 199). Successful artistic pieces have a complexity of inner relations of similar or different shapes, colors, or notes. Either deliberately or accidentally, all elements are positioned to produce a certain meaning. Each element in art may have particular meanings, yet it contributes to the bigger whole, which is larger than the sum of each part, as we can easily see in Klee's or Kandinsky's works.

Mary Catherine Bateson asks Gregory Bateson, "Daddy, can a scientist be wise?" (Gregory Bateson & Mary Catherine Bateson, 1977, p.73). Scientists who do not reduce flexibility while pursing rigidity can be wise. Blindly pursuing knowledge without noticing the value of love, the joy of dancing, and the rhythm of falling rain is not only blind but also dangerous. As David Lipset points out, cybernetics has the intellectual legacy of "at once uniquely flexible and ominously rigid" (Lipset, 1977, p. 51). Cyberneticists know the integrated fabric of mental processes that surrounds us. A meaningful pattern is frequently co-created, and these mutual selves are dancers in the cybernetic field, as Gregory Bateson and Mary Catherine Batson have demonstrated. The end of the metalogue concerning the question, 'what's a meta for' is William Blake's poem, the passage that a second order cybernetician pursued.

May God keep
From Single vision & Newton’s sleep! *(Gregory Bateson & Mary Catherine Bateson, 2005, p. 200)*

Strictly speaking, it is not Newton but Newtonians that are trapped by a single vision in perfectly predictable order. In fact, Newton's vision has a tension between rigid order of the material movement in physics and the imperfect and fallen yet emerging condition of human beings in theology. Newtonianism is an ideological project that confines human beings in a closed, ready-made system, which blocks the dance with the other as a subject to observe. This Newtonian notion of order reached its pinnacle in Laplace, whose system self-organization of the emergence of novelty is not allowed. Undeniably cyberneticists dream of “dances with wolves”, and to fully restore complex relations of beings destroyed by disciplinary rigor. Interdisciplinary rigor, to the contrary, attempts to build a complex system of relations against an exclusionary reductionism. At this emergent point, physics, biology, literature, design, and even holy religion converge with an “aesthetics of cosmic interactions” (Gregory Bateson, 2000, p. 306).

A mature cyberneticist has the wisdom and grace of noticing the whole from a part like a poet. As Bateson notices, every single detail of the universe participates in these cosmic interactions, which is fully realized in Blake’s “Auguries of Innocence.” When the interaction or dance with the other is made on a global scale, it becomes a cosmic dance. This cosmic dance produces beauty in a more inclusive system. Yet this cosmic dance is different from the predicted and prearranged position of participants in the Elizabethan worldview. This new aesthetics supported by second order cybernetics refuses Newtonian massive reductionism and values the imagination and increasing aesthetic sensibility for this cosmic dance.

Dancing has been traditionally classified as art rather than science. Yet as the leading second-order cyberneticists including Von Foerster and Gregory Bateson adopted it as the language of disciplinary and interdisciplinary interactions, the boundaries between art and science is narrowed and even blurred. In other words, now dance of language is not only for an artistic territory but also for a scientific one. Especially when interdisciplinary studies enter the territory of observing of observing, modeling of modeling, and communication of communication, this dance of language gets more prominent and significant. As scientific landscapes changes from reductionist trivialism dominated by classical physics to non-trivial monism with highly complex structure led by evolutionary biology and the sciences of complexity, more concern has been given to the reflective change in the process of learning, and the learning in the context of the context as the preconditions of reflexive knowledge. Dancing may not be necessary when carrying out the specific deductive operation or simply responding by correction of errors within a set of alternatives is good enough. Yet when science requires meta-thinking or met-meta thinking in a monism with highly complex interdisciplinary structure, aesthetic perception of wholeness and language of dance are inevitable. Imagination, as well as rigor, is necessary to reflect on reflection and learn about learning itself, and thus to create continually changing context in cybernetic relationships in interdisciplinary studies. Science without beauty does not require “aesthetic rigor”. Science with higher cybernetic loops requires aesthetics, and in this case, rigor does not contradict with imagination. In a higher cybernetic circle, rigor goes with imagination. The aesthetic rigor in interdisciplinary communication can be solidly based upon cybernetic wisdom. Gregory Bateson argued “rigor alone is paralytic death, but imagination alone is insanity” (Bateson, 1979, p. 219). His argument can be harnessed as a warning to both naive solipsist and easy reductionist who are engaged in contemporary interdisciplinary studies and projects without aesthetic rigor.

## 6. Conclusion

Synthesis, or the rigor of integration, is crucial in any meaningful intellectual interdisciplinary communication. Art may represent the processes and consequences of diverse and multiple interactions between intuitive and orderly, clarity and unclear possibility, and the truth and the beauty in interdisciplinary studies and projects. An effective communication requires a sense of beauty, joy in learning, and high sense of moral sentiment as well as restriction, and some rigors relevant to a poet or a mystic can be applied to a scientist in a higher cybernetic level. This could be called “aesthetic rigor”. Moreover, this aesthetic rigor with the language of dancing can be expanded into a global scale, connecting every swirling disconnected data in informatics. C. P. Snow, a British scientist and artist, deplored the split of the humanistic outlook and scientific outlook, and the lack of dialogue between them. This gap between two becomes miserably widened and is even potentially dangerous: with an increasing specialization, both scientists and humanists suffer from inquiring details of the other part. Academic worlds are torn apart, falling into a deeper abyss of futile monologue. Aesthetic rigor is concerned with the theory and practice of interdisciplinary communication and works as the cure to these two culture diseases. Aesthetic rigor, in this sense, is not only inter-disciplinary but also trans-disciplinary.

Contemporary interdisciplinary communication requires a high sense of morality and sensibility. The aesthetic rigor proposed in this paper is found in harmony and joyfulness, along with increasing choice and creativity. Ideal interdisciplinary communication is based upon balance, change, mutual respect, and love, all of which can be found in artistic masterpieces. Reflective and reflexive wisdom generate delight and joy in learning and practices. An interdisciplinary relationship can be expanded to the cosmic scales of harmony with aesthetic and ethical manifestations of art in a higher order. Aesthetic rigor, in this sense, can work as a cure when the healthy harmony between the Apollonian and the Dionysian is broken in interdisciplinary communication activities. As the artistic achievement of Greek tragedy featured an integration of seemingly opposite forces, an effective contemporary interdisciplinary communication requires not only logical rigor but also aesthetic rigor.

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# Intellectual Rigor in Arabic Studies and Computer Sciences Communication

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***Abstract***

*The current paper aims to find the most effective methodology for conducting interdisciplinary research at the intersection of Arabic Studies and Computer Sciences and to answer the question of How Intellectual Rigor May be Achieved in Inter-Disciplinary Communication? Despite certain contradictions of a methodological nature that arise in the process of interdisciplinary communication, it is the use of mathematical methods that often allows us to verify the results of researches in the field of humanities, to ensure the speed of data processing and their reliability. Assessing the effectiveness of this kind of interaction, the authors analyze the relevant level of intellectual rigor in the case of Arabic Studies and Computer Sciences communication. Today there is an urgent need to enhance the effectiveness of inter-disciplinary collaboration, and to improve criteria for assessing their quality. The research is based on the authors' many years of experience in implementation of research projects in the fields of Arabic Studies and ICT.*

***Keywords:*** *intellectual rigor, Arabic Studies, inter-disciplinary communication, Computer Sciences, methodology.*

## 1. Introduction

The requirements of modern science imply inter-disciplinary research that allows a comprehensive analysis of the object to be studied. At the same time, each discipline has its own approaches to research conducted over the years, a system of terms and concepts, and its intradisciplinary evidence based practice. The combination of different methods and approaches not always ensures the intellectual rigor of ongoing

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research at an interdisciplinary level. As a rule, priority is given to one of the scholar disciplines according to which "rules and regulations" the study is conducted, or it could be noted, that there is a minimization of requirements of each of the disciplines in the context of interdisciplinary dialogue. The article discusses the rigor in inter-disciplinary research in the case of Arabic Studies and ICT development. On the example of our recent publications and different scholar projects, we demonstrate the problem solving with the regard to multi- and interdisciplinary research.

## 2. Intellectual Rigor and Interdisciplinarity in Historical Perspectives

Interdisciplinary interaction is not a new phenomenon, but goes back deep into history. Beginning from the first decades of the *hegirah* the scrupulous study of the Qurʾan required an interdisciplinary approach in the analysis of the sacred text and participation of not only theologians but also linguists, as well as historians and specialists in Islamic Studies. Besides that, it was at the beginning of the 7th century, when a commission from five scholars implemented methods of statistical analysis while calculating the number of characters (323 015) and words (77 439) in the Qurʾan (Frolov, 2006).

Considering the issue of intellectual rigor in relation to ancient Arabic Studies, it seems that it was a comprehensive multi-disciplinary approach that ensured the quality of the research. For example, the author of the phonetic treatise of the beginning of the 11th century, Avicenna (Ibn Sina) was a physician, which allowed him to describe in detail the characteristics of sounds and the places of their articulation. Moreover, today the exclusively linguistic field of research, i.e. phonetics, explores not only the linguistic functions, but also the work of the articulation apparatus, as well as the acoustic characteristics of sound phenomena. Therefore, phonetics is also associated with non-linguistic disciplines, such as the anatomy and physiology of speech formation and speech perception, on the one hand, and with the acoustics of speech, on the other.

Multifaceted scholar activities of a researcher are considered the hallmark of the ancient times and the Middle Ages. It seems that history is repeating itself and now we are witnessing reflection of the past, but on a new stage of social development.

Within this framework, the following example is worth mentioning. It is well known that language is a reflection of social development. In this regard, an analysis of specialized terms in Arabic language confirms the close interaction of various fields of study in a historical perspective. Thus, the term *kalām* كَلام is the key concept both of the Arab-Muslim philosophy and the Arabic linguistics. The same may be said of the concept of *fiqh* فِقْه , which is primarily attributed to the field of the Islamic Law, but also to linguistics - *fiqh alluġa* فِقْهُ اللُّغَةِ – language grammar. There are many examples of this kind. On the one hand, they emphasize the fact of the interaction of individual disciplines, on the other hand, they verify that this homonymy is not just a coincides, since it helps to conduct comparative researches and to provide better understanding of the corresponding phenomena.

## 3. Humanities and ICT

Progress in modern science and technologies, the complexity of current scholar tasks require the usage of innovative methodologies including those based on inter-disciplinary research. In the present case scholar analysis involves experts in the fields of different sciences who perform multidisciplinary research that may addresses various clusters of texts or artifacts analysis and their further classification.

One of the advantages of this approach is not merely an overlapping either a combination of various scholar methodologies, or simply adding human efforts and skills, but amplifying benefits of each of the research attitudes involved. Because of objective analysis, it allows to put together all the related scattered qualitative and quantitative data, to discover interdependences and ties among different objects and, finally, as a result, to get the complete picture of the phenomenon under research. The mentioned before is fully correct in relation to modern Arabic and Islamic studies. The inter-disciplinary approach makes it possible to address issues that previously were out of scholars' sight or could not be solved by means of traditional methods or conventional attitudes.

Though interdisciplinarity is on the cutting edge of modern methods of research, a number of questions still remain. What are the criteria for the evaluations and conclusions, or how to keep the necessary balance among different methodologies applied? How to find common grounds for terminology and understanding of analyzed objects while tackling this critical issue?

## 4. The Case of Arabic Studies and Computer Sciences Communication

The first and very tentative steps of the use of digital methods in the analysis of the Arabic texts date back to the 50-60s of the last century, however, on a regular basis innovative methods have been applied only during the last few decades.

One of the recent projects of this kind was a research aimed at modeling and visualization of media in Arabic, which is also an example of international scholar cooperation and multidisciplinary research (Volkovich, Granichin, Redkin, & Bernikova, 2016). Linguists and mathematicians on the material of Arabic media, using a new method named the Mean Rank Dependency that allows pinpointing possible changes in social conditions reflected by the alterations in the style of the language of Arabic newspapers, carried the project. Similar ideas related to the need for a combination of methods of linguistic analysis and mathematical modeling, we also put forward in a number of our publications. In the run of these projects along with the problems of pure linguistic and mathematic character, we had to find common grounds and terminology and to develop our own sub-methods of research.

The importance of taking into account the so-called intellectual rigor at an inter-disciplinary level may also be exemplified by the analysis of the development of machine translation technologies. This task does not lie solely in the hands of mathematicians, but largely depends on linguists, who are able to take into account all the nuances of the Arabic language formalization. Analysis of available software applications, based on morphological analysis of word forms, let us suggest that they deal with only a limited number of algorithm for Arabic grammar description. Thus, some applications cannot provide a correct translation of the verbs in the feminine, subjunctive mood, while the translation of the same word forms in masculine are processed correctly. If there was a software that contains algorithms, which describe at least 70% of the inflectional paradigms of Arabic, the language processing errors would be reduced to a minimum (Bernikova & Redkin, 2016). Thus, some applied researchers not always correspond to the current state of the Arabic language linguistics.

## 5. Conclusions

Interdisciplinary communication involves the development of a special language of communication and research methodology that best meets the research rigor of each side of communication. This approach should be consistent, logical, and taking into account the entire scope of available knowledge on the topics addressed. In order to determine compliance with the level of intellectual rigor from the perspective of the various disciplines within which the study was conducted, a comprehensive expert assessment is required, provided by representatives of various fields of science.


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# "Intellectual rigor" and beyond: Interdisciplinary communication in a *glocalized* context (or *inter-scientificity)*

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***Abstract***

*This paper will challenge the present concept of "intellectual rigor" in an interdisciplinary communication and discuss how it should be expanded so that, on the one hand,* ***scientists*** *that move between at least two different linguistically discourses (i.e. in a glocalized context) can develop (1)* ***uncertainty and stress tolerance for unknown scientific terms*** *when trying to communicate their ideas in a different linguistic scientific environment; and (2)* ***association skills****, that is, skills in finding equivalences in two different linguistically discourses. On the other hand,* ***peer reviewers****, especially those who are monolingual (i.e. only English-speaking ones) and do not have any knowledge of OTHER scientific discourse(s) and socio-cultural context(s), should develop the necessary skills and understanding of what is entailed in not just an interdisciplinary communication but rather in an interdisciplinary communication in a glocalized scientific context.*

## 1. Interdisciplinary communication in a *glocalized*[1] context

### 1.1. The interdisciplinarity of various fields: An interdisciplinary challenge

Geography, Social Anthropology and History, Cultural Technology and Communication, Sociology, Marine Sciences (to name a few) are interdisciplinary fields of study that combine Social and/or Natural Sciences in the study of a broad variety of social and environmental phenomena, such as urban, regional and rural development, tourism development, migration, social exclusion, globalization, geopolitical conflicts, land degradation, desertification in a historical context. Thus, scientists of these fields must be equipped with the necessary knowledge, expertise and skills to analyze and recommend feasible and sustainable solutions to contemporary spatial, social, economic, and environmental problems (Kneale, 2003).

[1] For the notion of *glocal* and *glocalization*, see R. Robertson (1994, 1995, 2004, 2006 and 2013) and Nikolarea (2005 and 2019). Within the present context, *glocalization* is understood as diverse types of interrelationship and interdependency between local and global linguistic and cultural processes, which reveal the impact of the global (English as *lingua franca*) upon the local (e.g. Greek).

## 1.2. The interdisciplinarity of various fields: An interdisciplinary challenge for non-English scientists

It is precisely the interdisciplinarity of fields such as Geography, Social Anthropology and History, and other disciplines that become a multi-leveled challenge for non-English (e.g. Greek) scientists. Moreover, it is a challenge for them, because they usually have to search for and read a substantial number of references written in English (the global language) and use the knowledge acquired to the spoken and/or written local language, which is the language of instruction.

Nevertheless, during this process of moving back and forth between the two different linguistically discourses and *glocal* knowledge-based environments, scientists may face difficulties in understanding specialized texts written in English due to *the polysemy of a variety of terms* and *the lack of bilingual specialized dictionaries*.

Now, considering that most of these scientists are strongly interested in presenting their own research in international conferences and having it published in international journals, whose language of communication is English, then there are two sets of questions that can be raised: (1): *How can non-English **scientists** move with ease between <u>glocal</u> knowledge-based environments and communicate their research when they face the challenge not only of the lack of bilingual specialized dictionaries but also the polysemy of a variety of interdisciplinary terms, which - because they draw upon different disciplines - are now being re-contextualized and assuming a totally different meaning in the specific interdisciplinary field?*[1] And if it so, then (2) *how can **peer reviewers** become aware of the aforementioned difficulties that non-English scientists may have encountered, while writing a scientific paper, and what the latter claim may read "unfamiliar" and seem not to conform with their perception of "intellectual rigor"?*

# 2. Interdisciplinarity: A *topos* of "Inter-scientificity" and a challenge for "Intellectual Rigor"

## 2.1. Interdisciplinarity: A *topos* of "Inter-scientificity"

In this section, we will try to illustrate through one example how "interdisciplinarity" of specific disciplines in a *glocalized* environment becomes a *topos* of "inter-scientificity", a neologism, which was coined and introduced by the writer of the present article, first, in 2004 (Nikolarea, 2004) and then was discussed more thoroughly in Nikolarea 2006 and 2019.

[1] A similar claim is made by an ESP teacher of Marine Studies in Italy; see Reguzzoni 2006: 13-16.

Within the present context, we think that the neologism "inter-scientificity" should be explained. Although the second compound of the term is 'scientificity', this term is not used in a positivistic way but rather to indicate the application of linguistic methods and principles *either* to overcome problems of 'untranslatability' of scientific or domain-specific terms *or* to solve the problem of linguistic asymmetries between a pair of different linguistically scientific fields – for example, English: Greek, English: Spanish, Arabic: Greek etc. The problems of 'untranslatability' or linguistic asymmetries are usually created by the *polysemy* of scientific discourse in a *glocalized* context – that is, when **the global** (English) meets and interacts with **the local** (e.g. Greek). They are also common issues in Translation Studies that should be dealt with by translation scholars and practitioners (Maginot, 2015), and solution should be found if 'scientific' communication between two different linguistically scientific discourses (thus, 'inter-scientific') can be achieved. Nevertheless, what is common practice in Translation Studies is almost totally unknown in other scientific fields at non-English universities and in peer-reviewing in international journals published in English, due to the fact that ***scientists*** and ***peer reviewers*** (all ***parties involved***) are not trained (as translation practitioners are) to recognize these issues.

Therefore, in a non-English teaching context and in an international peer-reviewing context, 'inter-scientificity' is meant scientists and peer-reviewers' ability to move with ease between at least two linguistically different scientific contexts and comprehend inter-scientific differences not only across disciplines but also across different linguistic systems and cultures, without de-contextualizing scientific discourse from its respective linguistic, socio-political and cultural context(s). Thus, 'inter-scientificity' can be considered a skill or competence that all ***parties involved*** acquire as to how they can distinguish between various readings of a polysemous terminological entity (or *polyseme*) and can use this *polyseme* accurately in at least two linguistically different scientific discourses.

To illustrate what 'inter-scientificity' means in actual use and how complex and challenging is for all ***parties involved***, we will offer one example of 'inter-scientificity' in Figure 1, which we have repeatedly encountered it in our academic environment (i.e. in translating scientific papers into English, editing papers for international publication and in teaching ESP/EAP[1] classes for the last twenty years).

### *2.1.1. An Example of 'inter-scientificity'*

In our discussions with Social Anthropologists and students of Social Anthropology at the University of the Aegean, when we mention the term affinity, people are usually

[1] ESP: English for Specific Purposes and EAP: English for Academic Purposes.

stupefied and cannot understand what we mean. These responses usually make us realize that we are too presumptuous. We assume that colleagues and students would know the four Greek equivalents of this frequently-used English term, and that they would be able to select the correct equivalent by matching their respective meanings with the specific context in which the word occurred.

Thus, our colleagues and students' stupefaction has made us aware that this frequent word in English scientific discourse is polysemic in Greek, as shown in Figure 1.

| Affinity: (1) *Συμπάθεια*, (2) ***Αγχιστεία*, (3) *Έλξη*, (4)** *Χημική Συγγένεια* |
|---|

Figure 1: Greek polysemes of *affinity*

Now, we can see that, whereas in English one single word or one *lexeme* (i.e. affinity) denotes both general and technical meanings, in Greek four different words or four different *lexemes* or *polysemes*, as shown below, are used: (1) *Συμπάθεια* or "liking, fondness" for general meaning; (2) ***Αγχιστεία*** is literally translated as "non-blood relationship" usually by marriage or by ties other than those of blood (it should be distinguished from consanguinity) - [a term that is used in Social or Cultural Anthropology]**; (3) *Έλξη*** The third polyseme is literally translated as "Attraction" [and it is used in Chemistry]; **and (4)** *Χημική Συγγένεια* is literally translated as "Chemical relationship" [and it is used in Chemistry and Physical Anthropology].

So, Greek scientists and, especially Anthropologists, should: (1) know that, when Affinity is used in different linguistic environments, it may have four equivalents in Greek [see Figure 1, (1), (2), (3), (4)] and (2) identify which meaning this term acquires in a given scientific environment. In other words, if the term affinity is used in its social/cultural anthropological sense, then it stands for ***Αγχιστεία*** [see Figure 1, (2)], whereas if it is used in its physical anthropological sense, then it denotes *Χημική Συγγένεια* [see Figure 1, (4)]. The Greek scientists' ability to identify which meaning Affinity acquires in a scientific (con)text and transfer it to their language of instruction (i.e. Greek) appropriately is an issue of 'inter-scientificity'[1].

A further difficulty is that, whereas in English affinity can also be used as an adjective in a specific linguistic and scientific environment, in Greek it cannot. Therefore, the term affinity has been proven a complex case characterized by multi-leveled interpretations and uses in both languages as well as by grammatical and syntactical

[1] At this point, we should emphasise that English Social/Cultural Anthropologists and Physical Anthropologists may also have the same difficulty as their Greek counterparts with identifying which meaning *Affinity* acquires in a given scientific (con)text, thus encountering the same issue of 'inter-scientificity'. The difference lies in the fact that English **affinity** is just one term with four different meanings, whereas in Greek there are four different terms.

asymmetries across languages and scientific discourses.

Furthermore, we have observed that there have been two more issues involved:

(1) The linguistic context (oral and written) may not necessarily help us understand the meaning of affinity.
(2) Despite the fact a scientist may consult a general bilingual dictionary, s/he may not select the right meaning or *lexeme* either because s/he may not know how to use a bilingual dictionary or because s/he may not be aware of the other *lexemes* (and meanings) of the term.

## 2.2. Interdisciplinarity: A challenge for "Intellectual Rigor"

### *2.2.1. Non-English Scientists vis-à-vis 'inter-scientificity' and "intellectual rigor"*

As we have discussed in Section 2 of the present study, non-English (and sometimes English; see footnote 4) scientists in interdisciplinary fields encounter the issue of 'inter-scientificity', despite the fact that sometimes *they may not be fully aware of it*. It is also evident that scientists in interdisciplinary fields at non-English Universities face challenges that derive primarily from new academic requirements and market demands that force non-English scientists to communicate their research that is done in and for a **local** community and is written in a **local** language (e.g. Greek, Spanish, Arabic) to a **global** scientific community in the **global** language (i.e. English).

Now, if "intellectual rigor is a process of thought which is consistent, does not contain self-contradiction, and takes into account the entire scope of available knowledge on the topic, leaving no room for inconsistencies," ("Rigour" https://en.wikipedia.org/wiki/Rigour) then *how can a non-English scientist who is <u>not aware of</u> 'inter-scientificity and the multi-levelled linguistic asymmetries it generates take into account all the available knowledge and leave no room for inconsistencies?*

If a scientist is not aware of the issue of 'inter-scientificity', then, by definition, s/he cannot recognize from a cognitive point of view (Nikolarea, 2019) if there are any inconsistencies derived from linguistic asymmetries in his/her own effort to communicate his/her **local** interdisciplinary research to a **global** interdisciplinary community in English, the **global l**anguage. If it so, then the non-English scientist runs into the risk to be misunderstood, his/her research may be rejected on the premises of logical fallacy and, thus, **<u>no</u> inter-dsiciplinary communication is achieved**.

Therefore, one of the pressures that *glocalization* puts on non-English scientists is the demand for 'inter-scientificity,' a competence which can only be acquired through awareness and training. Therefore, we propose that non-English scientists, while they are undergraduate and/or graduate students, should be trained in how to carry out research into:

(1) Authentic materials written in English so to develop very advanced analytical and combinatory skills;
(2) Scientific bilingual terminology (Burdon 1988; Sager 1990), which demands:
    a. very advanced analytical skills; and
    b. very advanced synthetic skills;
(3) Machine translation (Nagao 1989), which demands both very advanced analytical skills, comparative and contrastive skills, if the scientist is to assess and correct the machine-translated text and use it in his/her paper.

Therefore, it becomes conspicuous that non-English scientists should be trained in 'inter-scientificity' by translation and terminology scholars (Baker 1997; Burdon 1988; Sager 1990) and lexicographers because only in this way they will be equipped with the necessary skills and understanding to develop:

- **Uncertainty and stress tolerance for unknown scientific terms**; and
- **Association skills**, that is, skills in finding equivalences in two different linguistically discourses.

### *2.2.2. English and non-English Peer-reviewers vis-à-vis "intellectual rigor" of a paper and interdisciplinary communication in a glocalized context*

But if 'inter-scientificity' with its the multi-levelled linguistic asymmetries challenges the exercise of 'intellectual rigor' in a non-English scientist's writing, this concept also challenges the exercise of 'intellectual rigor' in peer-reviewing papers written by non-English (international) scientists but from a different point of view.

'Inter-scientificity' challenges "intellectual rigor" in a peer-review as to how far a peer reviewer can go beyond certain "scientific conformities and conventions" and explore the "unchartered waters" of an innovative paper that is sometimes and somehow presented in an *"unfamiliar" (un+family; umheimlich – anoikeio [an+oikos])*[1] or a *"strange"* way; a scientific discourse that may incorporate "invisible" linguistic and cultural issues.

An English (especially a monolingual) peer reviewer is usually unaware of the issue of 'inter-scientificity' and the multi-levelled linguistic asymmetries it generates, which – in their turn – can also become carriers of cultural asymmetries. If it is so, then, when a peer reviewer tries to be as intellectually rigorous as s/he can, s/he can *fall into not just*

[1] It is worth noting that the English "unfamiliar", the German "umheimlich" and the (ancient) Greek *anoikeio* [an+*oikos*] cognate from "family" and/or "home" [*oikos*].

*an intellectual fallacy but also into a cultural fallacy*, because s/he is not able to detect or recognize incorporated "invisible" linguistic and cultural issues and, thus, s/he may reject *prima facie* (i.e. from the outset) a scientific paper or research that can be innovative and worth being published.

What we then can claim is that, a peer reviewer should: (1) become aware of the issue of 'inter-scientificity' and the multi-levelled linguistic and cultural asymmetries it carries; (2) be open to and flexible with a scientific discourse expressed in an *"unfamiliar"* or *"strange"* way; and (3) make constructive suggestions to the non-English writer as to how s/he can improve and make more communicable his/her own paper. Thus, the peer reviewer can help the non-English scientist achieve a global interdisciplinary communication s/he strives for.

## 3. Final thoughts and suggestions

Considering the complexity of 'inter-scientificity' and the multi-levelled linguistic and cultural asymmetries that it may generate, we should claim that the concept of **'intellectual rigor'** should be expanded so that, on the one hand, ***scientists*** that move between at least two different linguistically discourses (i.e. in a *glocalized* context) can develop (1) **uncertainty and stress tolerance for unknown scientific terms** when trying to communicate their ideas in a different linguistically scientific environment; and (2) **association skills**, that is, skills in finding equivalences in two different linguistically discourses. On the other hand, ***peer reviewers***, especially those who are monolingual and do not have any knowledge of OTHER scientific discourse(s) and socio-cultural context(s), should develop the necessary skills and understanding of what is entailed in not just an interdisciplinary communication but rather in an interdisciplinary communication in a *glocalized* scientific context. Should the concept of 'intellectual rigor' be expanded in this way, it will help, on the one hand, ***non-English scientists*** communicate better their ideas in a *glocalized* environment, and, on the other hand, ***peer reviewers*** understand better what is communicated to them in articles written in English by international scholars whose mother tongue is not English.

Finally, we are convinced that a **'safety pin'** in the process of peer review is the introduction of **non-blind review** – as done recently in the *$13^{th}$ International Multi-Conference on Society, Cybernetics and Informatics (IMSCI'19)* which was organized by the International Institute of Informatics and Systematics, because non-blind reviewers usually come from the same linguistically and culturally scientific context and can help, even enlighten, the assessment of a paper written by a non-English scientist in English.

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# Intellectual Rigor in Information Systems Development

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***Abstract***

*Information systems have two components. One id for Electronic **Data** Processing mainly via software and databases. The other is **information** processing which is, mainly, via human information processing. If this is evident, then it should also be evident that computing tools, techniques, and methodologies are **necessary** conditions. However, are they **sufficient** conditions? Obviously, the answer is NO. Then, why the curricula in computer science and/or engineering are almost completely covered by the necessary conditions related to Electronic Data Processing and almost none is related to human information processing? Should we expect from these computer scientists and/or engineering to be effective in developing information systems? Should not they also need preparation in human interactions, intellectual clarity in natural language notions and concepts, and not just knowledge and competence in artificial or programming languages? Shouldn't they be proficient in translating between artificial and natural semiotic systems, as well as in translating among different disciplinary semiotic systems? Shouldn't they,, also, be effective translating among different natural languages like the one used by Computing, business, and management people? Shouldn't, then information systems development teams be effective in inter-disciplinary communication? Shouldn't they also be intellectually rigorous in this kind of communications and not just correct and rigorous in communicating with computers? With this context in mind, we will try to shortly describe in this article the Intellectual Rigor Required in developing information systems.*

*Keywords: Rigor, Information Systtems, Computer Science, Computer Engineering, Software Engonnering, Human Information Processing, Software Crisis.*

## 1. Intellectual Rigor

Elsewhere, we are working on a more detailed article with regard to what "Intellectual Rigor" is (Callaos N. , The Notion of Intellectual Rigor: A Systemic/Cybernetic Approach, 2020). Let us here, in this first section, make a brief description of it, along with some specific questions that may support the kind of analogical thinking that would help in expressing the ideas of the following sections. Let us start some questions, in order to continue, with an initial example, along with few associated questions, related specifically to this initial example and, then, finish this section with more questions.

Is quantitative research more rigorous than qualitative research? Is it vice versa? Is the positivist paradigm more rigorous than non-positivist ones? Is it vice versa?

Do questions like these make any sense? Are we talking about the same kind of intellectual rigors? If not, why, then, we compare them as formally and informally has been done? Do different intellectual productions have different kind of rigors? If, so what are commonalities may we abstract from these different kinds of rigors? To try an answer to this question is the goal of this section, which is necessary to meet before addressing the issue of the *Intellectual Rigor in Information Systems Development.*

Francis Okyere (2016) encapsulated the volumes that have been written on positivism and non-positivism as follows, "While positivism uses ***validity and reliability as tests of rigor***, anti-positivistic research assumes a different stance. Anti-positivist thinkers strive for criteria pertaining to ***trustworthiness*** rather than absence of bias. They endeavour to achieve ***credibility*** (instead of internal validity), ***transferability*** (instead of external validity), ***dependability*** (instead of reliability) and ***conformability*** (instead of objectivity)." (Okyere, 2016, p. 131)

Now, let us suppose that we can produce an article with 1) *internal/external validity and reliability, as well as with* 2) *trustworthiness, credibility, transferability, dependability, conformability*, i.e. with both kinds of rigors: the positivistic and the non-positivistic one. Then, would not such an article ***have more rigor*** than those required just by the positive paradigm or by just the non-positive paradigm. As we will see below this kind of intellectual ***multi-rigor*** is associated to information systems development.

Now, let us address, briefly, the context of the next section.

## 2. Intellectual Rigor defined in terms of objectives and restrictions

Leonardo da Vinci's motto was ***"Ostinato Rigore***". As it is very known Leonardo Da Vinci was "Italian painter, draftsman, sculptor, architect, and engineer whose genius, perhaps more than that of any other figure, epitomized the Renaissance humanist ideal … His notebooks reveal a spirit of scientific inquiry and a mechanical inventiveness that were centuries ahead of their time." (Heydenreich, 2019). Jorge Allende interpreted Leonardo Da Vinci's notion of ***"Ostinato Rigore***" as relentless rigor, which "consists in the ***disciplined*** application of reason to subjects related to knowledge and or communication." (Rigor – The essence of scientific work, 2004) [Italics and emphasis added]

Since Leonardo da Vinci's work encompassed a high diversity of intellectual faculties (Science, Art, Humanism, Engineering, etc.), we may certainly take his conception of "*Rigore*" as applied to any intellectual field. This would mean that we can conceive "intellectual rigor" as the "***disciplined*** application of reason to subjects related to knowledge generation and/or communication."

Based on Leonardo da Vinci's integral, integrative, and integrated intellectual production, Jorge Allende adds the following:

> "Rigor is "***strict adherence*** to the truth, it is to disrobe ourselves of our prejudices and enthusiasm when we interpret our results, it is to search for all possible explanations of what we observe, it is accepting a result that demonstrates the fallacy of our most precious hypothesis … Rigor is in the essence of scientific work, in each one of the stages of the research work … Investigations start with questions [which always are related to a ***purpose***] that we ask ourselves about the universe, human beings, and nature that surrounds us … In science, communication is essential since it is the interface between the research authors and the rest of the world … This communication has to be rigorous in order to comply with the main ***purpose*** of publications" (Allende, 2004) [Italics and emphasis added]

It is evident, then, that ***"Intellectual Rigor"*** (in any, or most, intellectual fields) ***may be defined by objectives and restrictions***[1], as, for example, strict adherence to the Truth, to semiotic systems (disiplines), methods, etc. i.e. to ends and means. This is why a general definition of "intellectual Rigor" should be based on the ***"Means-Ends Logic"***. A disciplinary semiotic system is a means for achieving a Truth, according to an epistemological value. Different kind of truths is sought, according to the purposes of the seeker and, consequently, different means may apply. Means have usually restrictions, besides the restriction of the intellectual and physical environments. Consequently, "Intellectual Rigor" should be defined the following notions:

1) ***Purposes, objectives, or goals*** of the intellectual, (inquirer, researcher, artist, scientist, engineer, academic, professional, writer, etc.)
2) The ***effectiveness and/or the efficiency of the means*** used.
3) The context of the ***restrictions*** regarding:
    - The ***means*** (e.g. disciplines) and
    - The **environments** in which they are being applied (e.g., human, financial, managerial, technical, instrumental resources).

Now, before starting the next section of this article, let us ask some question, as *analogical examples* of what will follow in this article

- Which scientific discipline is more rigorous? Is this a valid question?
- Is Science more rigorous than Engineering? Is it vice versa? Are these valid questions? Do they make any sense?
- Who is more rigorous between a scientist and a Buddhist Monk? May both be equally disciplined and, hence, equally rigorous?
- How about a highly disciplined Buddhist Monk who happens to be also an excellent mathematician?
- What about a reputable physicist, while doing physics, and a great mathematician while doing mathematics? What happens of s/he applies her/his math to his work in physics or vice versa? Wouldn't this combined work be more rigorous? Isn't bi-rigorousness more rigurous than mono-rigorousness?

[1] This is the meaning of "Intellectual Rigor" used in this article, It is a working hypothesis based on abstracting what is common to all the definitions we have found, up to the present, in different intellectual activities: Science (including experimental and social sciences), Mathematics, Philosophy, Engineering, Art, Technological Innovation, Quantitative and Qualitative Research, etc. This is why we consider that this meaning is related the genre which species are the ways in which different kind of rigor has been defined in different disciplines.

- Isn't more rigorous to be able to meet more objectives with with a larger number of restrictions?
- How may we apply the above answer to inter-disciplinary communication?

**3. Rigor and Information systems development:**

Effective development of information systems requires intellectual rigor in different faculties of the intellect. It needs, at least, to meet the required rigor of 1) Computer Science, 2) System Engineering (including Software Engineering), and 3) an effective Logos of the related business and/or organization, i.e., at least, the Logos related to:

- Users of the future system, and
- The client contracting the system's development.

In other words, it requires, at least, intellectual rigor in three dimensions:

- Episteme (know-why),
- Techne (know-how), and
- *Phronesis* (practical knowledge).

  The later requires *Ethos* (trust), *Pathos* (empathy, emotion) and *Logos* (includes logic and language).

The identification of users' and/or clients' requirements requires also *Doxa* (opinion) and not just *Episteme* (justified belief) or knowledge, in general. Consequently, to be effective in information systems development, intellectual rigor should be followed in almost all dimensions of the intellect, or *functions* of the intellect (*nous*, using Aristotelic terms).

Each of these intellectual functions has their own *objectives and restrictions* in order to achieve the general purpose of developing an *effective* information system, especially if it is going to be made, (P*oiesis*), produced with an accepted and feasible efficiency. In contemporary terms, we may say that scientific, technological, and practical rigors should be adequately combined in the context of the rigor of a Singer/Churcham's (Churchman, 1971) pragmatic-teleological truth's rigor.

We suggest that a general definition (or, at least, description) of "intellectual rigor" should be congruent the ***objective(s)*** of the knower/doer in the context of intellectual and environmental ***restrictions.*** We are using the term "environmental restriction" in its general meaning, as related to the different standards, methods, and rules of the different semiotic systems required for the development of information systems. Consequently, scientific rigor should be met, as well as engineering, technological, and managerial rigors should also be met. The larger number of rigors is met, the more rigorous is the corresponding thinking/doing activities, because they have more objectives to meet in the context of more restrictions (methods, standards, rules, budget, time, resources, power struggles among users, uncertainties, etc.). This is the main reason why the required effectiveness in inter-disciplinary communication is a ***necessary*** condition for an adequate trade-off between effectiveness and efficiency (efficacy) in any project of information systems development

However, meeting effectiveness in inter-disciplinary communication is not a ***sufficient*** condition in these kinds of projects, because it is also required, to be effective (hence rigorous) in *Phronesis* (practical knowledge), *Poiesis*, *Ethos*, *Pathos*, and *Logos* (language and logic, including means-end logic).

In general, the solution of real-life problems requires more rigorous thinking/doing than scientific rigor alone, or just technological rigor. These rigors are necessary for real-life problems, but an effective implementation of the respective solution requires also complying with other kinds of thinking/doing rigors.

Developing an information system is a complex process which necessarily requires a complex (systemic/cybernetic) methodology, i.e. set or related, or relatable, methods along with their respective research methods and techniques, that may be adaptable to different computing technologies, business models, human environment, organizational cultures, unexpected contingencies, uncertainties, and all that characterizes the real world.

To bridge the abstract with the concrete requires *adaptation* to the *diversity* that characterizes concreteness as well as to its *changing* environment. Consequently, the *mono-rigor* of a specific discipline, be it in science or in technology, may have the required adaptability and flexibility to adapt the diversity and the dynamics of concreteness. Rigor is, by definition, rigid. Consequently, we need an interrelated set of actual and potential rigidnesses in order to get the required adaptability and flexibility. This does not mean less rigor, but more rigors in order *to relate* different intellectual rigors in order to achieve an objective while restricted to the changing constraints of what is concrete. Hence, we are referring here to the notion of ***meta-rigor, which is what we get with a systemic/cybernetic methodology of thinking and/or doing.*** Even Science alone requires an intellectual multi-rigorous approach, because the required pluralism of Science as a Whole. Shouldn't Peer Reviewing methodologies be aware with regards this issue? Shouldn't they be supported by multi-disciplinary perspectives? Shouldn't that be multi-rigorous and not mono-rigurous? Shouldn't they be based on meta-rigor, i.e. the rigor of relating different rigors? Should they be conceived in the context of a Means/Ends Logic, i.e, in Pragmatic-Teleological Truths as, for example, Singer/Churcham's (Churchman, 1971).

We may, potentially, make the following conclusions from this section:

1. Inter-disciplinary communication, to be effective, should be more not less rigorous, because it should fulfill the objectives and restrictions (standards, methods and rules, truth definitions or notions) of different disciplines.

2. Thinking/doing methodologies, for developing information systems, requires inter-disciplinary communication, as *necessary* but not *sufficient* condition. Hence, they require even more rigor, in order to meet the other objectives and restricted to more conditions, especially those related to financial, human, technical, and instrumental restrictions, as well as the emergent system requirements (objectives) and restrictions; which characterize dynamic environments, as usually are the human, managerial and physical environments of organizations.

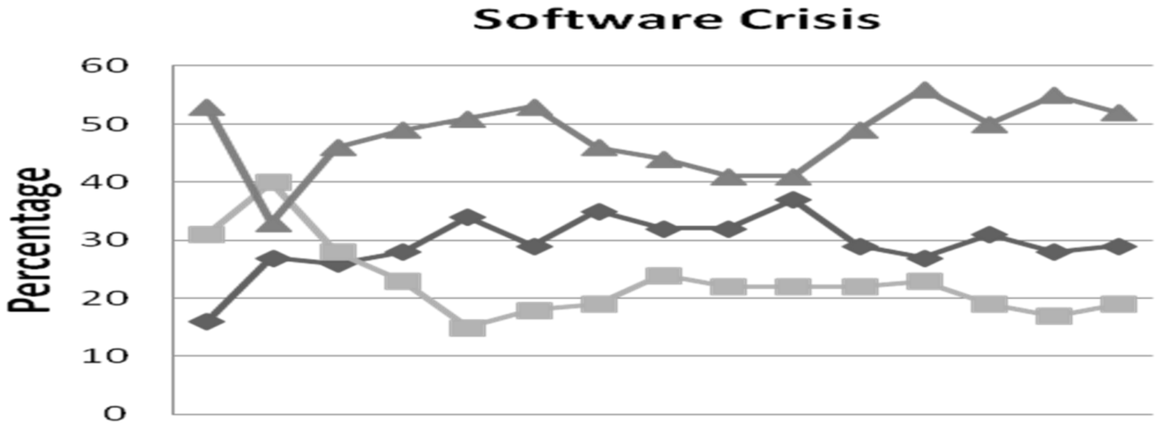
3. Hence, to the different rigors of the different disciplines, more rigor should be me in the implementation of any information system. Consequently, an effective development and implementation of information systems require to rigorously relate different kinds of rigors on thinking and in doing. To rigorously relate different kind of rigor might be named meta-rigors. A systemic network of different rigorous processes of thinking and doing is meta-rigorous, as long as it is effective, i.e. meeting the objectives sought in the context of both kinds of restrictions: those of thinking and those of doing.

4. We may suggest that, in general, real-life problem solving requires more rigor than the required on the different disciplines involved. It may even require meta-rigor, if the solution needs also to be *implemented*. This would require human beings, who may not have a disciplinary background and, hence, ***non-disciplinary communication*** might be required. Furthermore, it is probable that the solution would affect or impact human beings, and/or have human beings as its users. Consequently, Ethos, Pathos and logos should also be objectives with its respective means and (to be met) restrictions

5. An example of this kind of solution are methodologies for implementing artificial intelligence interacting with human intelligence. Artificial Intelligence is a very comprehensive inter-disciplinary field that requires and generates inter-disciplinary communication. So, it requires multi-disciplinary approaches, which, by definition, are ***multi-rigorous and, hence, to rigorously relate them*** (in the context of means-end logic and real life restrictions). This would require ***meta-rigorousness***, especially if it is going to be implemented in an environment where human beings are among its components. So, it is to be suggested that it would require not just more rigor, but also rigor at a second level, i.e. rigor in relating, not just, different scientific disciplinary rigor, but also the required rigors in *Techne*, *Phronesis* and *Poesis*, beside the Epistemic rigor of each of the involved scientific disciplines. Consequently, Artificial Intelligence should meet the requirements of different scientific and technological rigors but it also should meet the rigor of other intellectual endeavors if it is going to be implements and effectively embedded in human being contexts.

## 4. The Software Crisis

Another example could be found in the area of software engineering; which, actually, involves more disciplines than what it is perceived. This kind mis-perception is, in our opinion, one of the reasons and main cause of the so called *Softare Crisis,* where no significant improvement has been achieved in the thinking/designing/implementing software systems, since the term “software crisis” was coined in the first NATO Software Engineering Conference in 1968. The observed lack of efficiency and effectiveness in software development has been documented by the Standish Group in the last 18 years. The Standish Group's studies included ***more than 70.000 projects*** in information technologies. Figure 1 reports the most general results in the period of 1994-2015.




| | 1994 | 1996 | 1998 | 2000 | 2002 | 2004 | 2006 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Succeeded | 16 | 27 | 26 | 28 | 34 | 29 | 35 | 32 | 32 | 37 | 29 | 27 | 31 | 28 | 29 |
| Failed | 31 | 40 | 28 | 23 | 15 | 18 | 19 | 24 | 22 | 22 | 22 | 23 | 19 | 17 | 19 |
| Challenged | 53 | 33 | 46 | 49 | 51 | 53 | 46 | 44 | 41 | 41 | 49 | 56 | 50 | 55 | 52 |

**Figure 1**: The statistics of the Standish Group in the last 18 years. It is evident that there has been no improvement since the phrase" Software Crisis was coined since 1968.
*Source: The Standish Group: Chaos Summary for 1994-2015. Collected from several Standish Chaos reports, e.g. (Lynch, 2015), (The Standish Group International, Incorporated , 2012), (The Standish Group International, Incorporated , 1995) and (The Standish Group International, Incorporated, , 2013)*

Elsewhere, (Callaos & Callaos, 2014)[1], we noticed that

a. There has been no significant change since 1996 for the projects that succeeded (i.e., delivered on time, on budget, and with the required features and functionality); which percentage had been about 30% for about for about 20 years. The average is 29.333% since 1994 and in 2015 is 29 %. *This is truly astonishing.*

b. There has been no significant change since 2000 regarding failed projects (i.e., projects that were cancelled prior to completion or delivered and never use); which percentage had been about 20% for about 16 years. The average in the

[1] (Callaos & Callaos, Toward a Systemic Notion of Methodology: Practical Consequence sand Pragmatic Importance of Including a Trivium and the Respective Ethos, Pathos, and Logos, 2014)

time-period 1994-2015 is 22.8 % and in 2015 is also 19%. This is also astonishing.

c. A similar situation can be observed by noticing the percentage of challenged projects (i.e., that were late, over budget, and/or with less than the required features and functionality). The differences between years had been larger but the general situation still about the same that for the successful and the failed projects, The average in the time period 1994-2015 is 47.93% while in 2015 is 52%. Notice that in 1994 the percentage of challenged projects was 53% and 21 years later is 52%.

Isn't it perplexing that we are in the same situation we were 21 years ago in spite of all the research, the experience, and the technological innovations in the field that emerged in the field during this time? Should we continue solving the problem in the same way we have been trying to do it for at least 21 years? Is the problem a technological one? Couldn't it be a human one? Can't we guess that the source of the problem is a human communication as well as a cognitive, notional, and conceptual one? Shouldn't rigor be redefined here focusing on the objectives and restrictions and not just on the means?

A research made by IBM[1] identified five areas influencing project success or failure

- Project management (54%): Activities defining and controlling the IT project
- Business (21%): Aspects of the project dealing with project funding, internal rate of return and business data
- People (14%): The team that carries out the IT project
- Method (8%): The dimension involving approach, procedures and tools (*notice the con-fusion of methods with other notions, which are related but not the same as the notion of method*)
- Technical (3%): Aspects of the project regarding hardware and software, testing and interfaces between components

What is very clear in the IBM study is that the Human Dimension of the problem is more important than the scientific or technical dimensions. Consequently, any solution

[1] (Seven Reasons IT Projects Fail - Avoiding these pitfalls will help ensure success, 2012) and ( Five Areas Influencing Project Success or Failure , 2012)

should address the human subsystem in both: a) the developing phase as well as in b) the maintenance and operational phase. This would require to take into account the Human Intellect as a whole and not just its functions in Episteme (know-why) and Techne (know-how). Other intellectual dimensions (or functions should be addressed as well), i.e. P*hronesis* (practical knowledge). The latter (as we mentioned above) requires "*Ethos* (trust), *Pathos* (emotion) and *Logos* (including logic and language). Identifying requirements of the users and/or the clients require also *Doxa* (opinion) management.

Consequently, it is evident that the solution of this very important problem cannot be reduced to the fields of Computer Science and Systems/Software Engineering. As we showed in several articles and more than 100 empirical tests, via of professional and academic projects and 30 years of direct experience and complying with legal contracts, with the respective budgets and estimated times, other disciplines should get involved and, consequently, 1) the inter-disciplinary communication requires more diversified and complex processes and 2) other intellectual rigor should be met, including Phronesis, Ethos, Pathos, and Logos. The Logos require several semiotic systems, an adequate translations among them and, consequently, different kind of intellectual rigor; which should be related systemically in the context of a larger Logos based on the Means/End Logic and Singer/Churchman pragmatic-teleological truth and epistemology. More details regarding this issue can be found in the already mentioned publication (Callaos & Callaos, 2014), as well as at previous publications of other aspects or perspectives on this important issue.[1]

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[1] E.g., (Callaos & Callaos, A Systemic Definition of Methodology, 1991), (Callaos, Callaos, & Belkis, A Systemic Methodology for Information Systems, Analysis and Synthesis, 1992c) (Callaos, A Systemic 'Systems Methodology', 1992a).

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*Dr. Buus research* interest is on educational use of digital media and ICT focus on developing learning designs and the importance in scaffolding teachers in the integration process.

In her PhD thesis she has identified various learning potentials and challenges when teachers integrate web 2.0 mediated learning in their teaching practice. The thesis outlines a collaborative design methodology for the design of learning activities and learning processes that can be used to support teachers in their (re-)design of learning.

Her research shows that there is a need to organize an organizational support unit to scaffold and facilitate teachers’ design and implement their learning design. It is important as the “scaffolder” to have competences within the area of pedagogy and technology and keep in mind the philosophy: “We cannot design learning we can only design for learning” [Buus, 2016; Dirckinck-Holmfeld & Jones, 2009].

She contribute to the pedagogical and technological design and development of online and blended courses in collaboration with professionals in different domains. I'm involved in research projects looking into approaches of scaffolding teachers in organizing and developing learning designs.

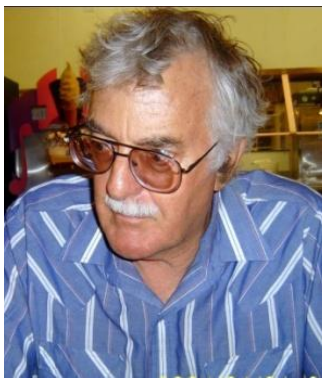
I have worked with integration of ICT and design of virtual learning environments in different educational contexts (educational organizations, workplaces, etc.) with a focus on the educational and organizational opportunities and challenges faced. I have conducted and participated in several development projects; both internal, national, inter-national and EU projects within my field of research, and I have experience as certified project manager.

Her specialties are: Scaffold and facilitate teachers integrate ICT in their teaching, Facilitate pedagogical learning designs and development of virtual learning environments, Integration of social media and web 2.0 activities in learning and teaching.

**Dr. Nagib Callaos, USA,** President of the International Institute of Informatics and Systemics, USA and Editor-in-Chief of the Journal of Systemics, Cybernetics and Informatics

Professor Nagib Callaos is the Founding President of the a 34 years old Multi-Disciplinary Organization oriented to 1) solve real life problems which mostly require multi-disciplinary teams and 2) to synergistically relate the disciplinary and inter-disciplinary departments of the University Simon Bolivar with the public and the private sectors, as well as with business and the Venezuelan society at large. He is also the Founding President of the IIIS and the Founding Editor in Chief of the Journal of Systemics, Cybernetics, and Informatics (JSCI). He is former Dean of Research and Development of the University Simon Bolivar.

Professor Callaos was also the founding president of several organizations on research, development, and technological innovation, e.g. The Foundation of Research and Development of the University Simon Bolivar, the founding president of the Venezuelan Fund for Technological Innovations (created by presidential decree), which required the evaluation of projects from any discipline as well as technological innovations that required multi-disciplinary teams. He was the Founding President of The Venezuelan Association of Executives in Patents and Copyrights. As a professional, Dr. Callaos was, for many years, consultant in Information Systems in the largest corporations in Venezuela including its Central Bank. In this context, he has been for 30 years the Founding president and CEO of a consulting firm in information systems and software engineering.  His main research, academic, and professional activities, along almost 50 years, were in the area of Systemic Methodologies of Information System Development, Group Decision Support Systems, and Action-Research mainly via Operations Research and The systems Approach. He tutored more than 100 undergraduate and graduate theses and produced more than 100 research papers and reflection articles. He has also edited, or co-edited many books, mostly conferences proceedings.



**Dr. Jeremy Horne, USA,** President-emeritus of the Southwest Area Division American Association for the Advancement of Science (AAAS), Consultant and CEO at Inventors Assistance League

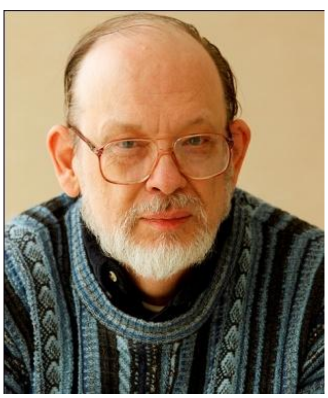
Dr Jeremy Horne is President-emeritus of the Southwest Area Division of the American Association for the Advancement of Science: AAAS. He currently the Chief Executive Officer of the Inventors Assistance League, a non-profit organization dedicated to helping independent inventors bring their creations to fruition.  He is doing research and writing in the areas of Logic as the language of innate order in the universe, which is an ongoing 40 year project.

His areas of specialization are: Logic (with course work in Symbolic Logic, Set Theory, Modal Logic, Computer-Managed Instruction in logic), Social and Political Philosophy, Political Economy, History of Philosophy, and Philosophy of Education His current research interests are in Recursion in three-dimensional binary space Modeling and Simulation – Autonomous hybrid systems, and states of life and consciousness, with emphasis on dynamic validation Organicity and consciousness in systems Relationship of first and second order logic to modeling theories, such as IDEF Cosmological and quantum semantics of binary logic Effect of millimeter wave radiation on transitional states of consciousness Consciousness studies, particularly the structure, role, and philosophy of bi-valued logic in consciousness Other topics in logic: paradoxes, unary set instantiation, proof checkers

Dr Horne taught many courses in political science and technology, delivered many presentations on the philosophy of scientific methods for the American Association for the Advancement of Science (AAAS) and Quantum Mind conferences, has been reviewer for various journals about the structure and process in binary space, consciousness studies, systems, theory, and philosophy of science, and Documentation Systems Developer, for White Sands Missile Range in New Mexico. His most recent publication consists of two chapters on the philosophy of binary logic and artificial minds in *Research and Applications in Global Supercomputing*, released by IGI Global Press March 2015.

**Professor Sukjin Kang**, **South Korea**, Korea Aerospace University, Faculty of Business School. Head of College of Liberal Studies. Director of Interdisciplinary Studies in KAU, Director of Korean Society for Teaching English Literature, Director of The English Language and Literature Association of Korea

Dr. **Sukjin Kang** is the Secretary for Research and Planning of The English Language and Literature Association of Korea (ELLAK): "an academic organization consisting of over 2000 members who have specialized in English linguistics, English education, English literature and culture, American literature and culture, and other literatures written in English. Members are holders of doctoral degrees from foreign institutions (over 80%) as well as Korean institutions of higher learning and teach at colleges and universities across Korea. Members are engaged in continuous research and take part in varied cultural and social activities in and out of their fields of specialization." This makes ELLAK an important hub for Inter-Disciplinary ans inter-cultural Communication. Consequently, it is a source of creative analogies, especially because disiplines has been conceived, perceived, and explained as academic cultures.



**Professor Thomas Marlowe, USA,** Seton Hall University, Department of Mathematics and Computer Science Program Advisor for Computer Science, Doctor in Computer Science and Doctor in Mathematics

Professor Thomas J. Marlowe has been a member of the Department of Mathematics and Computer Science at Seton Hall University for almost 40 years, and has taught a wide variety of courses in both disciplines. Until he went on phased retirement in 2017, he was coordinator and advisor for the Computer Science program. Professor Marlowe enjoys working with students and with professional colleagues—almost all his research is collaborative. His professional interests include in mathematics, abstract algebra and discrete mathematics; in computer science, programming languages, real-time systems, and software engineering, and pedagogy; and in information science, collaboration and knowledge management. The connection between graphs and algebraic structures is a recurrent theme. Professor Marlowe has Ph.D. in Computer Science, from Rutgers, The State University, and a Ph.D. in Mathematics, also from Rutgers. Professor

Marlowe has many publications and academic distinctions, with over 100 publications in refereed conferences and journals in mathematics, computer science and information science. Some of the more recent and more significant include:

- T.J. Marlowe, J.R. Laracy, "Logic as a Key to Integrating the Curriculum for STEM Majors", Journal on Systemics, Cybernetics and Informatics: JSCI Volume 15 - Number 4 - Year 2017, pp. 63-71, ISSN: 1690-4524 (Online)
- V. Kirova, T.J. Marlowe, C.S. Ku, "Monitoring and Reducing Application Fragility through Traceability and Effective Regression Testing", Genie Logiciel, No 115, 2-9, December 2015.
- A. Rountev, S. Kagan, T. J. Marlowe, "Interprocedural Dataflow Analysis in the Presence of Large Libraries", Proceedings of CC 2006, 216, Lecture Notes in Computer Science 3923, 2006.
- S. P. Masticola, T. J. Marlowe, B. G. Ryder, "Multisource Data Flow Problems", ACM Transactions on Programming Languages and Systems, 17 (5), 777 -803, September 1995.
- A. D. Stoyenko, T. J. Marlowe, "Polynomial-Time Program Transformations and Schedulability Analysis of Parallel Real-time Programs with Restricted Resource Contention", Journal of Real-Time Systems, 4 (4), 1992.
- T. J. Marlowe, B. G. Ryder, "Properties of data flow frameworks: A unified model", Acta Informatica, 28 (2), 121 -164, 1991.

Professor Marlowe has been a member on more than 10 Ph.D. thesis and 5 M.S. thesis committees, member of more than 25 conference program committees, and reviewer for numerous conferences, journals, and grants. He is the founder of an ongoing professional conference, and has been active with the IIIS and the WMSCI multi-conference.

**Dr. Ekaterini Nikolarea, Greece,** University of The Aegean, Greece, School of Social Sciences, Department of Geography.

Ekaterini Nikolarea got her BA in English Studies from Greece and her MA and PhD in Comparative Literature from Canada. She was awarded major Canadian Fellowships, Prizes and a Post-Doctoral Fellowship for her contribution to Translation Studies.

Ekaterini has published articles on theatre translation (the most known being "*Performability* versus *Readability*: A Historical Overview of a Theoretical Polarization in Theatre Translation." *Translation Journal* 6.4 (October 2002) (an electronic Journal). ISSN

1536-7207; viewed at http://translationjournal.net/journal/22theater.htm), reviewed books and articles and authored two Studies Programmes for Applied Linguistics. She taught World Literature, English and Greek (*Koine* and Modern Greek) in Canadian and US Universities, while being in North America.

Since she came back to Greece, Ekaterini has been teaching EFL, ESP and EAP in the Departments of: Geography, Social Anthropology and History, Cultural Technology and Communication, Sociology and Marine Sciences (of the School of Environment) at the University of the Aegean, Lesvos, Greece.

Ekaterini is an appointed ELT teacher in the School of Social Sciences at the University of the Aegean (Lesvos, Greece) and a Fellow of Institute of Linguists (IoL) in the UK. In her spare time, she does research on teaching foreign languages (especially, English) at a university level and works as a freelance bi-directional translator and interpreter, when her services are required.

**Dr. Bruce E. Peoples, USA,** Innovations LLC, Founder and CEO Formerly at Université Paris 8, France, Laboratoire Paragraphe. Chair Emeritus of an ISO/IEC Standards Committee, Generated over 50 Invention Disclosures, 15 Patent Applications and 11 Patent Awards

Dr. Bruce E. Peoples has over 27 years experience in researching and developing advanced complex training, performance, decision, and production support systems and has architected several advanced, "self learning" systems. His research activities led to the filing of over 50 Invention Disclosures and 15 Patent Applications. His inventions include the development of a cutting edge BCI system that controls the flight of an unmanned aerial vehicle using only thoughts. Dr. Peoples also designed and led development of the first paperless learning media production system that mass-produced digital "modular" information objects, also known as Sharable Content Objects (SCOs) that could be used standalone, as aggregations, or in Performance Support Systems and Decision Support Systems, in any delivery environment, without changing "module" code. In recognition of his past research, Dr. Peoples was awarded a Raytheon 2006 Excellence in Technology award. Dr. Peoples has been active in several International Standards Committees, developing the standards necessary for implementing "next gen" Information Communication Technologies on a global scale. He is Chair Emeritus of an ISO/IEC Standard Committee, ISO/IEC JTC1 SC 36 *Information Technology for Learning, Education and Training*. Dr. Peoples was awarded BS and MS degrees from Clarion University of Pennsylvania, and a PhD degree from Université Paris 8 Saint-Denis, France.

**Professor Oleg I. Redkin, Russia**, Saint Petersburg State University, deputy dean of science, head of the Arabic Chair, Faculty of Asian and African Studies.

Dr. Oleg Redkin is working as a professor (full) of Arabic Studies, deputy dean of science, head of the Arabic Chair, Faculty of Asian and African Studies, Saint Petersburg State University, Russia. He was born in 1959 in Vilnius. Dr. Redkin received his Ph.D. degree in Arabic linguistics in 1984 and Doctor Habilitation Degree (Doctor of Science) in 1999. His research interests include, but not limited to Arabic and Islamic studies, linguistics, computer text processing, ICT in Arabic learning. He published one monograph, three text books and more than 120 papers. He is one of the authors of two online courses on the Arabic language and one of the authors of two patented inventions. He is the member of editorial and scientific boards of several periodicals of Near Eastern, Arabic and Islamic Studies. He has been leader of several scientific research projects and grants.

**Professor Donald Ropes, The Netherlands:** Inholland University of Applied Sciences, Faculty of Business, Finance and Law.

Dr. Donald Ropes is Professor of Learning and Development in Organisations at Inholland University of Applied Sciences. He is also chair of the Business Research Centre at the same university. His research is on learning in complex environments, specifically how we can help people and organisations to become responsive: able to absorb shocks, adapt and thrive in new situations and look for challenges that can be turned into opportunities. For more than ten years, Professor Ropes has been working on advancing Design Science Research as a way to contribute to organisations' development while at the same time expanding organisational learning theory. His current interest lies in the field of transdisciplinary research as an approach to solving wicked problems.

**Professor Margit Scholl, Germany,** Technical University of Wildau, Faculty of Economics, Computer Science, Law. Built up a research-based and specific analog IT-Security Arena for people (employees, students, pupils) to raise information security awareness.

Professor Margit Scholl, PhD, is Professor for Business Informatics and Administrative IT in the Faculty of Business, Computing, and Law at the Technical University of Applied Sciences Wildau (TH Wildau) situated to the southeast of Berlin. Her research and teaching work centers on process and project management, (mobile) business applications, information security and privacy protection including baseline protection and awareness, multimedia approaches, and learning methods. Prof. Scholl has assembled a team for research projects in the area of innovation in teaching and learning. The team is completely supported by external funding, in line with the fact that the TH Wildau has a strong focus on the combination of research and teaching. The team has been carefully chosen to bring together a broad range of interdisciplinary approaches, application-oriented research, and modern teaching experience. She has developed a “Certified Further Training Course for IT Security Officers in Public Administration and SMEs” and a “Certified Further Training Course for Data Protection Officers in Accordance with the EU GDPR for Public Administration and SMEs.” In addition, she offers trainings and examinations for the European Computer Driving License (ECDL), with the prospect of further trainings in the future for practitioners and consultants in IT baseline protection (IT-Grundschutz) in line with ISO/IEC 27001. A parallel certification hierarchy has also been put in place for students.